Students Taking Advantage of Resources (STAR): A Model to Promote Effective Study Habits and Autonomous Learning

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Developing high-utility, effective study strategies and knowing how to manage one's own learning are essential to student success during formal education. Self-initiated and self-managed learning creates lifelong learners and self-regulated learning is strongly correlated with academic achievement in college and beyond. However, many students lack the autonomy to know how they learn best and what study strategies yield the best results in exams. These students may be unaware of available academic resources and how to use them. Integrating compulsory assignments that provide students with learner choices containing study strategies along with structure and guidance with which to experiment promotes self-regulated learning behavior and motivation to learn. This can help students take greater responsibility for their own learning and develop effective study habits they can use throughout their college education. This paper describes the Students Taking Advantage of Resources (STAR) model, which provides a menu of learner choices that encourage students to take advantage of available academic resources such as online educational systems, textbook resources, tutoring services, peer-assisted study sessions (PASS), and instructor office hours. Students select STAR learner choices and earn points for using the STAR resources. Points obtained from the STAR model account for 10% of their course grade. Requiring STAR activities positively reinforces students' use of the resources they should already be using to succeed in college. The results of the model application demonstrate a consistently positive relationship between students' use of these strategies and their exam scores. Although this relationship may not necessarily be a causal one, the STAR model helps students create effective study strategies and succeed in college.

Far too many degree/certificate-seeking undergraduate students in 2-year colleges do not complete their programs within a reasonable amount of time or do not complete them at all. The Integrated Postsecondary Education Data System (IPEDS) reported a 35.7% graduation rate within a 3-

year period for the cohort year 2016 at 2-year colleges nationwide (NCES, n.d.). Similarly, the Ohio Department of Higher Education reported a 53% 3-year success rate for the Fall 2017 entering cohort at 2-year colleges in Ohio (Ohio Higher Ed, n.d.). Among many significant contributing factors to these low graduation rates is students' lack of effective learning techniques. Study skills and strategies play a crucial role in determining students' academic performance, and they exhibit the strongest relationships with grade point average and grades of individual courses more than any other individual examined behavioral factor (Bartoszewski & Gurung, 2015; Credé & Kuncel, 2008).

One explanation for students' lack of effective study techniques is that as a society, students are often not taught how to learn. Instead, content delivery is prioritized (Kornell & Bjork, 2007). Another part to this problem is the disconnect between students' perception of motivation and preparedness versus their actual behavior. This disconnect has been clearly suggested by the results from the 2020 Survey of Entering Student Engagement (SENSE) (Center for Community College Student Engagement, 2020) conducted in Fall 2019. According to the SENSE report, 86% of student participants agreed or strongly agreed that they had the motivation to succeed in college, and 82% agreed or strongly agreed that they were academically prepared to succeed in college. However, for students who started college in Fall 2019 at 2-year colleges, the persistence rate was about 58.5%, and the retention rate was less than 51.6% nationwide (National Student Clearinghouse Research Center (NSCRC), 2021). According to the SENSE report, 65% of students never discussed ideas from readings or classes with instructors outside of class, 70% never used any writing, math, or other skill labs, 81% never used any sort of face-to-face tutoring, and 81% never participated in a nonrequired student-initiated study group outside of class.

This disconnect between students' perceptions of their abilities and their behaviors clearly demonstrates that our students need guidance and incentives to use resources and create study strategies for success, especially during their first year in college. Another aspect of the problem is students' metacognitive illusions, such as believing that their ineffective learning techniques are actually good, which leads them to poor self-regulation and low achievement. For example, students use less effective easy-processing strategies such as massing and rereading than more effective strategies such as spacing and self-testing (Kornell & Bjork, 2008;

Simon & Bjork, 2001). Less effective strategies may just be the easiest options in the short term or that is all they know and often fail to weigh their strategies with their test scores. Over the past couple of decades, cognitive and educational researchers have worked to develop and evaluate effective, easy-to-use learning techniques to improve educational outcomes (Bartoszewski & Gurung, 2015; Dunlosky, 2013; Dunlosky et al., 2013).

One solution is to educate students about basic principles of human learning and memory related to activities and techniques that enhance information storage and retrieval and how one can enhance and improve information acquisition, retention, and retrieval by proper monitoring and controlling of one's learning activities (Bjork et al., 2013; Bjork & Bjork, 1992; Dunlosky et al., 2007). Implementing a self-selected study plan that involves both cognitive and metacognitive processes of planning, selecting, and organizing. Planning includes defining study tasks, setting goals, and creating a timeline. Selecting includes spaced study, self-testing, elaboration, and critical thinking whereas organizing includes outlining the material and resources to use. All these are important for the advancement of self-regulated learners (Bjork et al., 2013; Cukras, 2006; Nist, 1993; Pressley, 1995). Assessing, monitoring, and controlling are useful strategies to evaluate their self-selected study plan. Assessing has to do with whether learning has been achieved with self-testing, monitoring includes judging whether to keep learning or terminate learning, and controlling involves continuing to use the same strategy or changing to a new strategy. The effectiveness of their self-selected study plan relative to their performance will help students become strategic learners (Cukras, 2006; Dunlosky et al., 2007). Another solution is to provide help, guidance, and incentives for students to actively engage with the best practices of self-regulated learning.

In this paper, we discuss a model that encourages students to take advantage of available academic resources within the University of Cincinnati Blue Ash College (UCBA) campus. The STAR model provides students the ability to experiment with effective learning techniques by providing structure and guidance. One of the main goals of the STAR model is to promote and stimulate self-initiated and self-managed learning, which can help students take greater responsibility for their own learning and develop effective learning habits and techniques they can use throughout their college education and later in life. Within the STAR model, five different types of academic resources are introduced. Students are encouraged to experiment with as many as they wish to begin with, and eventually, they are asked to stick with one or two resource types that best suit their personalities and learning styles. This initial process promotes metacognitive monitoring (knowing which resources are the most effective and how they help in learning the material and enhancing test performance) and metacognitive control (knowing which resources one should continue to use and which should be dropped when and why). These are the key characteristics of a self-regulated learning process (Bjork et al., 2013). The learning techniques embedded in the STAR resources are rated by many evidence-based research studies as having moderate to high utility across a wide range of categories of variables for generalizability, such as student characteristics, learning conditions, materials, and criterion tasks (Dunlosky et al., 2013). Most of the generalizability variables discussed in these studies are readily applicable to the UCBA physics program.

Textbook rereading/practice problems resource type involves rereading, studying an example, and attempting to solve a practice problem given at the end of a section. This process is repeated for each new concept/section. Students typically need to study the example problem(s) before attempting the practice problem, which means they need to read and understand the concepts underlying the example problem discussed in that section (spaced rereading). Then they study the example (monitoring that the concept is understood) and return to complete the practice problem (self-testing). These three strategies—spaced rereading, monitoring, and self-testing—combined in spaced repetitive conditions yield a promising learning technique referred to as *successive relearning* (Rawson et al., 2013).

Although massed rereading is one of the strategies that students most frequently report using during self-initiated study, researchers have rated it as having low utility across many variables of generalizability (Bahrick, 1979; Rawson & Dunlosky, 2011). Instead, many researchers suggest self-testing is a superior learning technique with higher utility for enhancing learning and retention because it triggers the creation of retrieval pathways of stored information (Carpenter, 2011; Pyc & Rawson, 2010; Zaromb & Roediger, 2010). Within the STAR model, under this resource type, students relearn and self-test in study events to prepare for the four tests that are spaced evenly throughout a semester. This learning technique that is involved in this STAR resource type promotes and advances self-regulated learning activities.

Tutoring services STAR resource type promotes and stimulates an important self-regulated learning strategy referred to as *adoptive help-seeking* (Butler, 1998; Karabenick & Berger, 2013; Karabenick & Newman, 2013). Because students use tutoring services to gain explanations of the principles leading to the problems' solution or to learn the process rather than just soliciting the solution, help-seeking is instrumental in promoting learning and understanding (Nelson-Le Gall, 1981). Researchers have categorized help seekers into three types based on their motivation to seek or avoid seeking help. There types are achievement goal-focused motivation, mastery-focused motivation, and ability-focused motivation. Achievement goal-focused motivation drives the student to care more about completing an assignment and the grade than task persistence and are more likely to ask for the answer. Mastery-focused motivation steers the student to care about improvement, understanding, and persistent growth of knowledge whereas ability-focused motivation causes the student to believe that there is a stigma around seeking help and that it threatens their competence and self-esteem (Butler & Neuman, 1995; Karabenick, 2004). Ability-focused students are usually the poorest performing and need the most help but may not seek help due to feeling desperate or intimidated or due to the lack of help-seeking skills (Karabenick & Knapp, 1988, 1991). In contrast, the mastery-focused and goal-focused students are more plausible, rather than less plausible to seek help when needed however, these active learners may not seek more help rather less due to their escalate efforts, task endurance, and use of other learning strategies decrease the need for it (Karabenick & Knapp, 1988, 1991).

Little to no quantitative research is available that examines the ways in which learning assistance centers such as UCBA's math lab enhance students' academic skills and tests results. However, their strong presence within open-access 2-year colleges that provide many services, including tutoring to support the development of science, technology, engineering, and math (STEM) skills suggests their valuable developmental and remedial role in increasing student preparedness for college-level courses (Boylan, 2002; Perin, 2004). The main function of academic support centers is to help students develop efficient learning processes—an especially important function considering instructors' observations of academic difficulties that impede content learning in college-level courses (Grubb & Worthen, 1999; Perin & Charron, 2006).

The General Physics (GP) students who participated in this study often mentioned math lab tutors when prompted to "Please list at least two things about this course that helped you learn," which was given in the student course evaluation portal. "One described the center as having 'the most positive environment on UCBA campus!'" Another responded with, "The math lab is wonderful and the people there made me fall in love with math. Thank you!" (UCBA Math Lab Survey, Fall & Spring, 2018). Some math lab users responded that the center was too loud and crowded, the center needed more tutors, tutors needed to be nicer, and the tutors needed to be better trained to help students. According to the math lab manager, the tutors had not had much success in connecting and building cohesive student groups mainly because UCBA is a commuter college.

Instructor office hours and Peer-Assisted Study Sessions (PASS) are two other resource types within the STAR model that promote help-seeking learning strategies. In previous studies, researchers examined possible associations between help-seeking motives and preferred sources of help, finding a strong link between mastery-focused motivation and using teachers/instructor office hours as resources and finding that neither mastery-focused or achievement goal-focused motivations correlated with students seeking help from their peers (Karabenick, 2004; Karabenick & Knapp, 1988). The mastery-focused physics students in this study were more likely to seek help when confronting difficulties they considered insurmountable and to seek help in a way that increased autonomy. Participants in this study who used instructor office hours mostly asked for explanations of principles and concepts rather than answers to problems or explicit help on assignments. In contrast, a few students who came to get help on homework and other assignments, but they were less likely to pay attention to the concepts and the process than the answers and help completing the assignments according to instructor observations. The students who are motivated by mastery largely use instructor office hours to seek autonomy in comparison to those who are motivated by achieving goals, who largely use PASS help. These two resource types are underutilized due to temporal constraints and limited hours according to the students.

Interactive video vignettes are superior to many conventional out-of-class assignments and can be used effectively to teach difficult physics concepts such as collisions and Newton's Third Law (Laws et al., 2017). This STAR resource type develops and restores two learning techniques that are rated as having moderate to high utility: elaborative interrogation and self-explanation (Dunlosky et al., 2013). Elaborative interrogation prompts students to answer “why” questions, which leads them to generate explanations for stated facts. This technique helps establish the learner’s prior knowledge by supporting the integration of new information with existing information and enforcing the retrieval of prior knowledge (Willoughby & Wood, 1994). Similarly, self-explanation, which involves having students explain the “why” using concepts and principles, can enhance learning by supporting the integration of new information and enforcing retrieval of prior knowledge (Berry, 1983).

In this analysis, we will explore students’ use of resources and the relationships and correlations between resource use and test scores. Specifically, we will answer the following questions: What are the most used resource types? What patterns can be observed in their resource usage behaviors over the course of a semester? What learning techniques and habits, if any, did students adopt over the course of a semester? What is the relationship and correlation between total STAR points earned and final exam scores? What resource type has the most significant correlation with final exam scores? How does the relationship and correlation differ for individual resource types and midterm exams? Which resource type has the most significant correlation with improved midterm exam scores? How does the correlation between the STAR points earned and test scores progress over a semester? Do any trends exist in these correlations? Finally, what correlations, if any, exist between different resource types?

The answers to these questions will provide insight into the implications of students’ behavior when using academic resources by choice versus when they are prescribed and how these behaviors impact students’ course performance. Perhaps this paper will serve as an impetus for colleagues in all disciplines to consider meaningful avenues for increased student use of academic resources in both on-campus and remote settings.

Methods

Participants of the STAR Model

Of the 196 total participants in the present study, 123 students (55% female, 45% male) were enrolled in 10 sections of General Physics I (GP I) in the Spring 2015, Fall 2015, Fall 2016, Fall 2017, and Fall 2018 semesters, and 73 students (67% female, 33% male) were enrolled in seven sections of General Physics II (GP II) in the Spring 2016, Spring 2017, Spring 2018, and Spring 2019 semesters at UCBA. University of Cincinnati Blue Ash College had an average of about 4,600 students per semester between Fall 2015 and Spring 2019. On average, about 61% of them were white and 20% were African American; 59% were female, and 61% were full-time. The group of participants in this study represented a sample of 2-year college students in the STEM disciplines. The GP sequence consisted of GP I and GP II, which are each one semester long and are taught in the Fall and the following Spring. Each course is designed to introduce non-physics majors to basic concepts in physics. This sequence is required for students seeking admission to medical, veterinary, pharmacy, engineering, biotechnology, and other graduate programs. Each semester, a new batch of students enrolls in the GP courses.

GP Course Assessment Structure

The assessment structure of the GP course consists of three tests (40% of the course grade), a final exam (20%), pre-lecture assignments and homework (10%), test revisions (5%), quizzes (10%), in-class assignments (5%), and STAR points (10%). The tests and the final exam questions/problems do not come directly from publisher test banks or practice problems in the textbook. These questions are designed by the instructor to suit the material taught in the classroom and presented in the textbook. Apart from the workload of scheduled class time, the GP content itself is a challenge for most students, and it demands that students spend at least 6 to 8 hours weekly outside of class studying the material and completing assignments.

Resources Included in the STAR Model and Reporting Methods

Course Textbook Reading/Practice Problems

Students receive two STAR points per section for completing practice problems listed under that section. Each chapter contains approximately 10 sections, and 10 chapters are covered for each course (GP I and GP II). Practice problems can be found at the end of any example problem discussed in the textbook (Walker, 2008). Students typically need to study the example problem before attempting the practice problem, which requires they read and understand the concepts underlying the example problem being discussed in that section. Students submit their full, handwritten solutions to the practice problems to the instructor on test day, earning credit for completion/accuracy.

Textbook-Supplemental Interactive Video Vignettes

In the physics courses, students receive two STAR points per section for completing video vignette assignments listed under that section. Video vignettes are short web-based assignments designed as supplements to the textbook and can be found at the textbook companion website. Each vignette presents a video of a scientific phenomenon, asks for the student's prediction about it, and then asks the student to conduct video observations or analyses that allow the user to compare findings with their initial prediction. The STAR model requires students to write down their predictions, findings on the phenomenon, and the physics concepts and the formulas that explain the results. Students submit their full, handwritten work to the instructor on test day, earning credit for completion/accuracy.

Math Lab Tutoring Services

University of Cincinnati Blue Ash College tutoring services is a popular resource among STEM undergraduates that offers help on a drop-in basis for all undergraduate levels of mathematics, physics, and statistics. The UCBA tutoring services center is staffed with qualified and dedicated academic and student tutors who follow established tutoring guidelines and procedures, including working through notes and textbook examples, clarifying concepts, providing one-on-one instruction, and facilitating peer-based group studies. The tutoring services center operates 60 hours each week during the academic year, including evenings and weekends. Students are required to sign in through a computerized tracking program every time they enter the tutoring services center and sign out when they exit. The system records the student's name, entering and exiting times, and the purpose of the visit. The instructor can request this information from the tutoring services manager. Students earn one STAR point for every hour spent in the tutoring services center on work for physics courses.

PASS (Peer-Assisted Study Session)

The UCBA PASS program, a STAR option for students in the physics courses, is designed to improve student learning by creating a network of study peers outside the classroom. These sessions are collaborative learning environments led by capable student leaders who have demonstrated strong performance in physics. Peer-Assisted Study Session leaders are selected by a faculty mentor who is also a physics professor. Students attend scheduled 2-hour sessions, which are held in a designated room two to three times weekly, to work on homework assignments; solve practice problems; review lectures, readings, group work, and discussions; and learn study skills. All physics students are notified of weekly PASS schedules by their physics professors and are continuously encouraged to attend these sessions. Within the STAR model, students earn two STAR points for attending a session. Peer-Assisted Study Session leaders are required to report student attendance and a description of the material and assignments that were discussed to the instructor via weekly emails.

Instructor Office Hours

The instructor conducts 2-hour office hour sessions three times weekly right after lectures and has additional times available by appointment. Students receive two STAR points each time they visit to receive help with course material. Students are required to write their name and the purpose of their visit on a sign-in sheet posted by the instructor's door.

Implementation of the STAR Model

Students Taking Advantage of Resources points are required component of the course and constitute 10% of students' grades. The earned grade percentage is proportional to the number of points earned, and students are required to earn 100 points to receive the full 10% of the course grade. In the first week of classes, the instructor informs students about the STAR component of their grade, explaining the rules and resources available within the STAR model to obtain the required points and the rationale for the model. The instructor also highlights the availability of the tutoring service center and PASS sessions. Students receive a handout containing the schedules of these resources. Also, the instructor distributes a printed copy of a description of the STAR model's use within the class (see Appendix A). At the end of each test, the instructor updates students' intermediate grades, including STAR point grades, in the Blackboard grade book. Students' STAR point scores are also updated in Blackboard four times each semester.

Statistical Analysis Method

We used simple linear regression analysis to determine the relationship between total STAR points earned and final exam score at 5% level of significance. In this analysis, total STAR points was used as the independent variable and final exam score was used as the dependent variable. We also measured the Spearman's correlation coefficient and the strength of the association by the Spearman's correlation coefficient. We performed multiple regression analyses to determine the relationships between individual resource types and midterm exam 1 scores at 5% level of significance. The same process was repeated for midterm exams 2 and 3 scores and their corresponding resources types. In each of these cases, the midterm exam scores were used as the dependent variables, and their corresponding resource types were used as the independent variables. All assumptions for both simple linear regression and multiple regression as well correlation were tested.

Results and Discussion

STAR Resource Usage

Between-Resources Variability in Use

Table 1

Total Points Earned and Academic Resources Used by General Physics (GP) Students Who Participated in the STAR Points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	GP I:123 students		GP II:73 students	
Resource Type:	Average points earned±SEM	% of students who use the resource	Average points earned±SEM	% of students who use the resource
Textbook Practice Problems	40±3.5	48%	46±4.2	50%
Tutoring Services	17±3.0	36%	19±4.3	34%
Instructor Office Hours	2.5±0.6	16%	4.4±0.8	23%

Video Vignettes	8.0±1.5	12%	6.0±1.4	14%
PASS Sessions	2.3±0.5	16%	2.3±0.6	12%

Note. Total use of resources by General Physics students in the STAR points system reported by different methods. Average usage of the resources are computed over five and four semesters for General Physics I and II respectively.

The most used method among the resources introduced by the STAR model was textbook reading/practice problems and the tutoring services center (Table 1). Comparing the average percentage of students who used textbook reading/practice problems with those who used video vignettes (Table 1) clearly demonstrates that students prefer resources that align with assessed material and provide the necessary skill set for assignments designed to enhance conceptual understanding of assigned topics. A similar result of students' underutilization of instructional videos has been shown in earlier research (Huon et al., 2007). This suggests that students underutilize videos regardless of whether they are instructional or video vignettes.

Although tutoring services, PASS sessions, and instructor office hours share a common characteristic of seeking help through a human tutor, our study shows that GP students prefer to get help from the tutoring service center. This might be because office hours and PASS sessions are at restricted times, which can be challenging for commuter students. Additionally, this outcome might be because most of our GP students are driven by achievement goal-focused motivation and not mastery-focused motivation. Previous studies suggested a strong link between mastery-focused motivation help-seekers and using teachers/instructor office hours as resources (Karabenick, 2004; Karabenick & Knapp, 1988). Our results showing students' preference for one resource type over another is contradictory to Inglis et al.'s (2011) finding that multivariate calculus students did not make heavy use of any one resource. However, that study involved a different set of resources which includes face-to-face lectures, online-recorded lectures, and a mathematics learning-support center. Overall, the resource usage and the points earned for different types of resources were similar between GP I and GP II students, except GP II students showed a higher tendency to use instructor office hours compared to GP I students. GP II students attended office hours twice as often as GP I students on average (Table 1). The average numbers of total STAR points earned by GP I and GP II students per semester were 70 points out of 100 points and 78 points out of 100 points, respectively, indicating that students use more resources and learning strategies when they getting more matured in their college program (Table 1).

Behavior and Patterns of Student Resource Use

Next, we looked at the variation of use for each resource over the four test quartiles in a semester for GP I and GP II students.

Table 2(a)

Per Test Quartile Points Earned and Academic Resources Used by General Physics I Students Who Participated in the STAR Points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

Resource Type:		GP I: 123 students			
		Test 1 qtr.	Test 2 qtr.	Test 3 qtr.	Test 4 qtr.
Textbook Practice Problems	% of students who use the resource	46%	46%	52%	50%
	Average points earned±SEM/maximum allowed points	8.19±0.89/30	8.74±1.03/20	11.41±1.14/28	11.79±1.37/20
Tutoring Service	% of students who use the resource	27%	33%	45%	38%
	Average points earned±SEM/minimum required points	2.67±0.59/20	3.88±0.75/20	5.36±0.93/20	5.39±1.02/20
Instructor Office Hours	% of students who use the resource	15%	16%	17%	15%
	Average points earned±SEM/minimum required points	0.59±0	0.62±0	0.68±0.17/10	0.57±0.14/10

		.14/10	.15/10		
Video Vignettes	% of students who use the resource	5%	11%	13%	19%
	Average points earned±SEM/maximum allowed points	0.33±0.16/12	1.76±0.59/14	1.98±0.54/14	3.95±0.89/6
PASS Sessions	% of students who use the resource	22%	19%	14%	10%
	Average points earned±SEM/minimum required points	0.69±0.14/8	0.58±0.12/8	0.53±0.14/8	0.50±0.15/8

Note. A test quartile of a semester is defined as the time duration between two consecutive tests, which is about a month. Average usage of the resources are computed over five for General Physics I.

Table 2(b)

Per Test Quartile Points Earned and Academic Resources Used by General Physics II Students Who Participated in the STAR Points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

Resource Type:		GP II: 73 students			
		Test1 qtr.	Test2 qtr.	Test3 qtr.	Test4 qtr.
Textbook Practice Problems	% of students who use the resource	51%	51%	59%	41%
	Average points earned±SEM/maximum allowed points	10.40±1.39/32	10.00±1.45/18	14.78±1.70/30	10.53±2.09/18
Tutoring	% of students who use the resource	22%	33%	44%	21%

Service	Average points earned±SEM/minimum required points	3.99±1.16/20	6.65±1.70/20	6.34±1.54/20	1.56±0.61/20
Instructor Office Hours	% of students who use the resource	27%	30%	37%	23%
	Average points earned±SEM/minimum required points	1.10±0.24/10	1.12±0.24/10	1.59±0.31/10	0.58±0.16/10
Video Vignettes	% of students who use the resource	10%	14%	16%	13%
	Average points earned±SEM/maximum allowed points	0.92±0.37/6	1.53±0.54/6	2.47±0.73/10	1.12±0.47/4
PASS Sessions	% of students who use the resource	10%	15%	19%	2%
	Average points earned±SEM/minimum required points	0.27±0.11/8	0.55±0.17/8	1.45±0.45/8	0.03±0.03/8

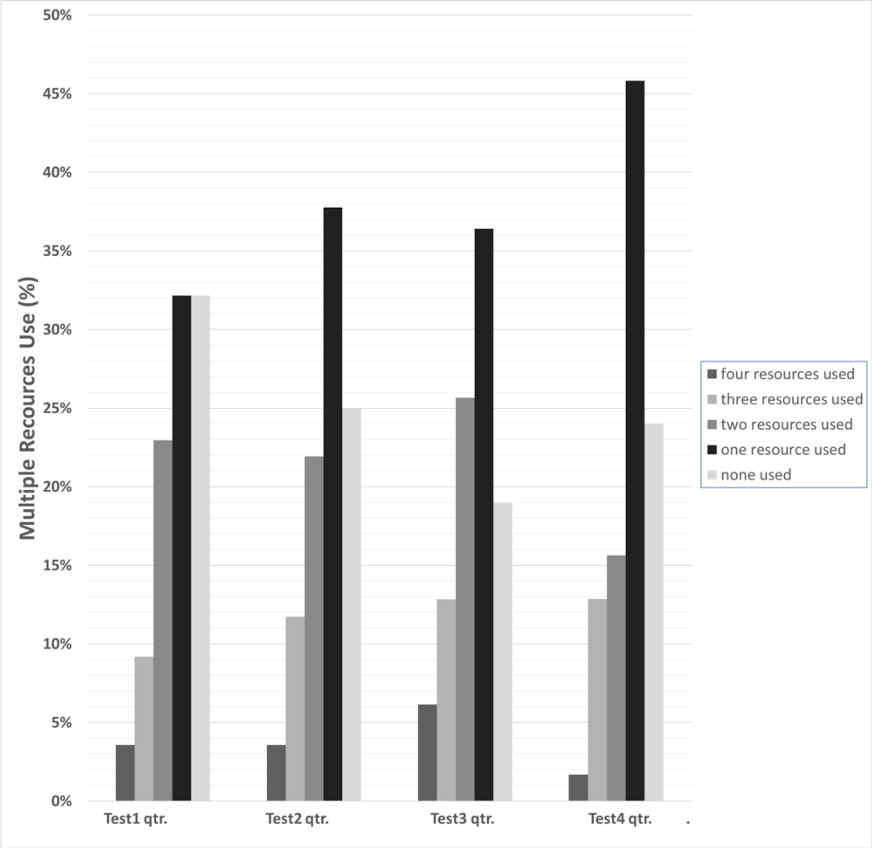
Note. A test quartile of a semester is defined as the time duration between two consecutive tests, which is about a month. Average usage of the resources are computed over four for General Physics II.

There was a steady increase (or stasis) in use of almost every resource type up to and including the third test quartile and then a sudden drop during the fourth test quartile (Table 2(a) and 2(b)). This sudden drop might due to students becoming overwhelmed by end-of-semester deadlines. This trend is not visible in the use of PASS sessions and video vignettes in GP I students; instead, a different trend emerges in the gradual decrease in the use of PASS sessions and gradual increase in the use of video vignettes over a semester.

We noticed that the overall usage behaviors over a semester were similar between GP I and GP II students with a couple of exceptions. Overall, we noticed that increasingly more students started using STAR resources during the semester. The maximum number of STAR points students are allowed to earn per test quartile for textbook practice problems and video vignettes depends on the number of sections covered before each test (Table 2(a) and 2(b)). Average points earned as a percentage of maximum points allowed per test quartile vary between 25% and 60% for textbook practice problems and 2.7% and 66% for video vignettes during a semester (Table 2(a) and 2(b)). The maximum points allowed per test quartile for PASS depends on the number of PASS sessions conducted that week as well as the length of a test quartile, which is about a month. Students were advised to earn at least 8 points per test quartile. The average points earned as a percentage of minimum required points per test quartile in this category vary between 0.4% and 18% during a semester (Table 2(a) and 2(b)). Similarly, the maximum points allowed per test quartile for instructor office hours and tutoring services depend on the number of hours a given service is available per week as well as the length of a test quartile. The GP students were asked to earn at least 10 points for office hours and at least 20 points for tutoring services per test quartile. The average points earned as a percentage of minimum required points per test quartile for office hours and tutoring services vary between 6% and 16% and 8% and 33%, respectively, during a semester (Table 2(a) and 2(b)). Regarding GP students' STAR resource usage specifically, office hours and PASS sessions are at a significantly lower level compared to textbook resource and tutoring service usage, which are at a reasonably higher level. Overall, GP students STAR resource usage is not great, but reasonable.

Figure 1

Simultaneous Use of Multiple Resources by General Physics students who participated in the STAR points program at University of Cincinnati Blue Ash College from 2015 to 2018.



Note. Average percentage variation in the use of multiple resources by General Physics students in the STAR points program over a semester during the nine-semester period. Data from four test quartiles are presented.

We noticed trends in the percentages of students using multiple resources. There is a clear trend of an increase in the one-resource-used percentage and a decrease in none-used percentage over the course of a semester, showing that students' resource use tended to improve, and increasingly more students tended to use one resource type (Figure 1). Although the two-resources-used percentage stayed at a relatively stable level within the first three test quartiles, it dropped significantly (by ~10%) during the fourth test quartile (Figure 1). The three- and four-resource-used percentages seemed relatively low at ~12% and ~4%, respectively, and stayed relatively stable throughout a semester (Figure 1). These results indicate that the students who used no resources and those who used two types of resources at the beginning of the semester tended to use only one resource type toward the end of the semester. The one-resource users predominantly adopted either textbook resources or tutoring services. At the beginning of a semester, GP students who primarily selected two resources in order to discover the right strategy for them and those who selected none both tended to adopt one study strategy that they had found effective during the semester. This behavior of self-selecting, measuring effectiveness, and revising accordingly was shown in previous research to be a method students commonly use when provided with multiple resources (Cukras, 2006). Our results, which show students' tendency to use a single resource type, agree with a study done by Inglis et al. (2011), which found that students clustered in the use of predominantly one type of resource.

Resource Use and Academic Performance

Another aim of our study is to determine how students' use of resources influences their academic performance. To address this, we conducted a series of regression analyses and correlation analyses, each conducted to identify correlations, associations, or predictive relationships between use of resources and academic performance.

Relationship Between Total STAR Points Earned and Final Exam Score

We performed simple linear regression analysis to determine the relationship between total STAR points earned and final exam score. In this analysis, total STAR points was used as the independent variable and final exam score was used as the dependent variable.

Table 3

Linear Regression Analysis Between the Final Exam Score and The Total STAR Points Earned by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	t-test statistics	df	P-value
Total STAR points	3.739	194	0.0002

Note: STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

The total STAR points of all the source types is significant ($\alpha = 0.05$, p-value = 0.0002, n = 196, F-statistic=13.98, $df_1=1, df_2=194$, $R^2=0.0672$). This means that all the resource types together have a positive effect on final exam score. So, we can conclude that there is a positive relationship between total STAR points earned and the final exam score (Table 3).

Correlation Between Total STAR Points Earned and Final Exam Score

Next, we conducted correlation analysis to determine whether there was an association between total STAR points earned and final exam score. We used Spearman's correlation coefficient.

Table 4

Correlation Analysis Between the Final Exam Score and the Total STAR Points Earned by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	Final exam score (r)
Total STAR points	0.2541365

Note: STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

In this analysis, we measured the Spearman's correlation coefficient and the strength of the association by the Spearman's correlation coefficient. Our results indicated a positive (weak) correlation between total STAR points earned and final exam score.

Relationship Between Individual Resource Types and Midterm Exam Grades

We performed multiple regression analysis to determine the relationship between individual resource types and midterm exam 1 scores. The same process was repeated for midterm exams 2 and 3 scores and their corresponding resource types. In each of these cases, the midterm exam scores were used as the dependent variables, and their corresponding resource types were used as the independent variables.

Table 5(a)

Multiple Regression Analysis Between the Midterm Exam 1 Scores and the Points obtained from the Different Individual Resource Types by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	t-test statistics	df	P-value
Textbook Practice Problems	2.321	190	0.0213
Tutoring Services	-2.197	190	0.0293
Video Vignettes	1.293	190	0.1976
PASS Sessions	0.491	190	0.6238
Instructor Office Hours	-0.111	190	0.9114

Note: PASS refers to Peer Assisted Study Sessions. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

Our results show that both textbook practice problems and tutoring services have a significant effect on midterm exam 1 scores at $\alpha = 0.05$ level of significance with the sample size of 196 (Table 5(a)).

Table 5(b)

Multiple Regression Analysis Between the Midterm Exam 2 Scores and the Points obtained from the Different Individual Resource Types by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	t-test statistics	df	P-value
Textbook Practice Problems	2.219	190	0.0244
Tutoring Services	-0.702	190	0.4838
Video Vignettes	-0.302	190	0.7628
PASS Sessions	0.675	190	0.5008
Instructor Office Hours	0.761	190	0.4475

Note: PASS refers to Peer Assisted Study Sessions. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

Our results show that textbook practice problems has a significant effect on midterm exam 2 scores at $\alpha = 0.05$ level of significance with the sample size of 196 (Table 5(b)).

Table 5(c)

Multiple Regression Analysis Between the Midterm Exam 3 Scores and the Points obtained from the Different Individual Resource Types by the General

Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	t-test statistics	df	P-value
Textbook Practice Problems	2.100	190	0.0370
Tutoring Services	-0.395	190	0.6932
Video Vignettes	1.940	190	0.0538
PASS Sessions	1.100	190	0.2727
Instructor Office Hours	0.880	190	0.3801

Note: PASS refers to Peer Assisted Study Sessions. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

Our results show that textbook practice problems has a significant effect on midterm exam 3 scores at $\alpha = 0.05$ level of significance with the sample size of 196 (Table 5(c)). Therefore, the resource type that is most significant with the midterm exam scores is textbook practice problems.

Correlation Between Individual Resource Types and Midterm Exams

We conducted Spearman's correlation analysis to determine whether there was an association between individual resource types and midterm exam scores.

Table 6

Spearman's Correlation Coefficients Between the Midterm Exam Scores and Individual Resource Types Used by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018.

	midterm1	midterm2	midterm3
Textbook Practice Problems	0.2013	0.1572	0.0903
Tutoring Services	-0.2249	-0.0639	-0.0838
Video Vignettes	0.1572	-0.0099	0.1648
PASS Sessions	0.0161	0.0386	0.1093
Instructor Office Hours	0.1180	0.0588	0.0677

Note: PASS refers to Peer Assisted Study Sessions. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

There is a positive association between textbook practice problems and midterm grades, and the strength decreases across the midterm exams (Table 6). One contribution to this decrease in the association strength could be the progressively challenging subject material that is tested over the course of the midterm exams. Students' use of this resource type showed a significant increase during test quartile 3 (midterm exam 3 preparation), which could provide evidence of difficult content covered within the later chapters of the textbook (Table 2(a) and 2(b)). There is also a positive association between PASS sessions and midterm exam grades, and the strength increases across the midterm exams (Table 6). We also observe a negative association between tutoring services and midterm exam grades across all midterm exams (Table 6). Although the records show an increased use of this resource type over the first three test quartiles (Table 2(a) and 2(b)), it is hard to determine if the visits are to get help with physics or other courses.

Correlation Between Resource Types Under Various Midterms

Table 7(a)

Spearman's Correlation Coefficients Between the Various Resource Types Used by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018 Under Midterm Exam 1.

	Textbook	Tutoring	IVV	PASS	Office Hours
Textbook	1.0000	-0.0890	0.1560	0.0980	0.0858
Tutoring	-0.0890	1.0000	-0.0399	0.1876	0.2307
IVV	0.1560	-0.0399	1.0000	0.0357	0.1298
PASS	0.0980	0.1876	0.0357	1.0000	0.3233
Office Hours	0.0858	0.2307	0.1298	0.3233	1.0000

Note: PASS refers to Peer Assisted Study Sessions. IVV refers to Interactive Video Vignettes. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

There is a moderate negative correlation between textbook practice problems and tutoring services (Table 7(a)). This means that as the number of students who use textbook practice problems increases, the number of students who use tutoring services moderately decreases and vice versa. The dominant behavior of this two-resource usage is that students do not use the two at the same time. The adaptation of the two learning techniques involved in these resources—rereading/self-testing and adoptive help seeking—should show an inverse correlation as well. In contrast, the textbook practice problems and the video vignettes have a moderately positive correlation, which is to be expected because the two are similarly accessible (Table 7(a)). There exist moderate positive correlations between textbook practice problems and each of the latter two resources in the table 7(a). Tutoring services shows moderate positive correlation with PASS sessions and instructor office hours, which could be due to the fact that they all share common learning techniques which is adoptive help-seeking (Table 7(a)).

Table 7(b)

Spearman's Correlation Coefficients Between the Various Resource Types Used by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018 Under Midterm Exam 2.

	Textbook	**Tutoring**	**IVV**	**PASS**	**Office Hours**
Textbook	1.0000	-0.0642	0.0776	0.1454	-0.0484
Tutoring	-0.0642	1.0000	-0.0338	0.3069	0.3483
IVV	0.0776	-0.0339	1.0000	0.0571	-0.0198
PAAS	-0.0145	0.3069	0.0571	1.0000	0.2892
Office Hrs	0.1572	0.3483	-0.0198	0.2892	1.0000

Note: PASS refers to Peer Assisted Study Sessions. IVV refers to Interactive Video Vignettes. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

Correlations that exist between the main STAR resource types under midterm exam 2 are very similar to those exist under the midterm exam 1 (Table 7(b)).

Table 7(c)

Spearman's Correlation Coefficients Between the Various Resource Types Used by the General Physics Students Who Participated in the STAR points Program at University of Cincinnati Blue Ash College from 2015 to 2018 Under Midterm Exam 3.

	Textbook	Tutoring	IVV	PASS	Office Hours
Textbook	1.0000	-0.1191	-0.0270	0.0004	0.0443
Tutoring	-0.1191	1.0000	-0.0282	0.4482	0.3908
IVV	-0.0270	-0.0282	1.0000	-0.0061	-0.1228
PAAS	0.0004	0.4482	-0.0061	1.0000	0.3915
Office Hrs	0.0443	0.3908	-0.1228	0.3915	1.0000

Note: PASS refers to Peer Assisted Study Sessions. IVV refers to Interactive Video Vignettes. STAR refers to Students Taking Advantage of Resources. STAR points refer to the points awarded to students for using the five resources.

The correlation between textbook practice problems and video vignettes shows an inverse effect under midterm exam 3 (Table 7(c)). This observation contrasts with the correlation between the two that we saw in the first two midterms (Table 7(a) and Table 7(b)), and it is difficult to explain this behavior. However, the significantly lower usage and the lower points earned in the latter three resource types (Table 1) could be associated with the inconsistency shown in the correlations within the three resources across the three midterms.

Conclusions

The STAR model provides a menu of learner choices that encourage students to take advantage of available academic resources such as online educational systems, textbook resources, tutoring services, PASS, and instructor office hours. This model was implemented for students in 17 sections of General Physics at the UCBA campus over 5 academic years (2014/15, 2015/16, 2016/17, 2017/18, and 2018/19). Data from nine semesters were analyzed to understand how the resources are being used, emerging study habits, any associations between resource use and academic performance, and relative importance of STAR menu choices.

The STAR resource types used most by GP students were textbook practice problems and tutoring services, reconfirming our hypothesis that students tend to use resources most aligned with testing material instead of using resources that enhance deeper understanding of the subject.

Additionally, relatively heavy use of tutoring services suggests that the majority of GP students who seek help are motivated by the achievement of goals, and they seem to avoid help from their instructor. Our results indicate that three learning techniques—rereading, self-testing, and adoptive help-seeking—were adopted most often by the GP students in this study.

We found that students selected multiple STAR menu choices. However, the dominant behaviors were one-resource use, two-resource use, or no resource use. The use of one resource tended to increase, and the use of two resources or no resources tended to decrease over the course of the semester. Overall usage of STAR resources by students increased, per test, over the duration of a semester, and students appeared to adopt a single strategy (a single resource type) that worked best for them toward the end of a semester.

A positive correlation and a positive relationship were observed between total STAR points and final exam scores. Textbook practice problems was the only individual resource type that had a significant effect on all the three midterm exam grades. Additionally, this resource type showed a positive association with the three midterm exams. However, the association strength appeared to decrease across the three midterms over the semester. Tutoring services showed a significant effect only on midterm exam 1 and showed a negative association across all midterm exams. Correlations between various resource type usage under each midterm were observed. A moderate negative correlation was observed between textbook practice problems and tutoring services across all midterm exams. However, there was a positive correlation between textbook practice problems and the video vignettes, as well as between tutoring services and each of PASS sessions and instructor office hours across all midterm exams.

By providing a menu of a variety of structured resources and requiring participation as part of the course grade, instructors encourage students to experiment with study strategies they might not otherwise try. Furthermore, our results suggest that allowing students to self-select learning resources helps them identify the resources that are most helpful to them over time, and therefore they learn to study more effectively and efficiently.

Appendix A

General Physics
STAR POINTS SYSTEM
Students Taking Advantage of Resources – STAR

You have access to so many resources that will lead to your success in this course! I want to be sure you take advantage of them, so a portion of your grade will be determined by your use of these resources.
You can select from any of the five activities listed below. You do not have to do all five; choose the one(s) that you like best. The due dates and the points awarded vary, so be sure to read the description of each for details. The more activities you complete, the higher your score will be. *Your star points are worth 10% of your final grade.* The total amount of points that you need to earn over the course of the semester is 100, it is not unreasonable for you to earn the full 100 points.

1) **Reading your textbook – 2 STAR points per section**
   Read one current section in the textbook and complete all the "Practice Problems" (Listed under each Example) on a sheet of paper. Show all the work. Your answer should be in *GIVEN, FIND, EQUATION* format to earn the full points. On the top of the first page, be sure to write your name, STAR – Text, and the section it covers. Hand in the exercises to me on the date announced in class, usually the day of an exam. You will earn 2 STAR points per section.

2) **Textbook Interactive Video Vignettes (IVVs) – 2 STAR points per video**
   Watch one current section's interactive video, available with the text book or listed under some chapters in the Bb, and take notes write down the physics concept discusses in the video, answers to interactive questions come with the video. You can find two types of videos (author demo videos and video tour demonstrations) under the study area in the online homework site. Hand in the notes, concept covered and the answers to the questions to me on the date announced in class, usually the day of an exam. You will earn 2 STAR points per video.

3) **UCBA Math Lab – 1 STAR point per hour**

For every hour that you spend in the Math Lab doing *physics problems* or getting help from drop-in-tutor for your *physics assignments* in Muntz 112G, you will earn 1 STAR point. Be sure to sign in when you arrive and sign out when you leave. Also, clearly state the purpose of the visit. You get points only for doing physics related work in the Math Lab. (I can verify that you were there doing physics with the Math Lab Manager).

4) Office Hours – 2 STAR point per visit
Come to my office hours, Mon., Tu., and Wed. from 12:20 PM to 1:20 PM, in M366A, or make an appointment with me at another convenient time to get help on assignments, get help on understanding the material covered in the class, get help on preparing tests and exams etc. Each visit count as 2 STAR points. Make sure to sign your name and date when you enter my office.

5) **PASS sessions - 2 STAR points per one PASS session**
A PASS leader conducts PASS session in the Math LAB every week (once or twice a week) to help on HW, quizzes, tests and challenging questions. If you participate one of these sessions you will earn 2 STAR points. Participate as much as you can to earn points.

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