

Effective Study Skills and Habits for College
Students Majoring in
Science, Technology, Engineering, and
Mathematics

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Winter Quarter 2021

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Abstract

Students entering university as Science, Technology, Engineering, and Mathematics (STEM) majors often times lack the necessary study skills to be academically successful. The lack of study skills plays a huge role in students struggling academically but sometimes it can be one of the many reasons students drop out of school. Students often times would have to learn study skills and habits when they are in their first year of college. As they learn study skills, their academic performance usually improves over time. The goal of this paper is to investigate the reasons why students go into college with little to no study skills, analyze some study habits students develop, and look into the relationship between study quantity vs. quality. Interviews have been conducted with STEM students where they provided detailed information about their experiences in developing their study skills and the advice they have given. Along with the responses from the interviewees, this paper will support the primary research with secondary research in several sections of this paper. Major findings were that study skills play more of an important role on the quality side instead of the quantity. This means that students who study with effective methods are more successful academically rather than students who study more with less effective methods. Along with that fact, there are several roles that affect a student's academic success in an indirect role such as keeping good mental health and having self-care activities.

Section 1: Introduction

Most students who enter UC Davis or any 4-year university as a STEM major usually experience a huge academic transition from high school to university. The biggest change is becoming an independent learner by having good study skills and routines. The problem is that most students don't have the necessary study skills and routines to prepare them for university which becomes an unpleasant surprise for most. As a first-generation third-year undergraduate student majoring in STEM, specifically engineering, I too was also unprepared when coming to UC Davis. I came in with the mindset that I can use the habits I used in high school to get a high-Grade Point Average (GPA) without much studying. This became an unpleasant surprise to me and even others who share the same experience since we earned grades we were not satisfied with due to a lack of study skills, routines, and habits we didn't have or learned. After the first quarter of my freshman year, most undergraduate students realize to succeed in STEM, a good set of study skills, routines, and habits are needed to be successful.

Now to understand why a good amount of undergraduate STEM students, especially the first years, come to university with a lack of study skills and habits, we have to look back at high school. Most high school teachers would say they are preparing their students for university but unfortunately, the reality is that it's not true most of the time. The reason being is that high school and college are structured differently. Aniva Kartika, who is a faculty at the University of Surabaya in Indonesia, explains the difference between high school and college in her research article, "Study Skills Training: Is it an Answer to the Lack of College Students' Study Skills?", about having a summer intervention program for incoming college students by teaching them study skills. She explains that high school students are typically taught most of the material, told

what they need to learn, and tested more frequently while not applying much critical thinking. This leads to high schools only giving necessary class materials and even being told what they need to learn to pass or get a good grade. This doesn't give the students the incentive to develop their study skills and habits which will translate into their college academic lives. Kartika mentioned that "In college, students are required to know how to study by themselves, which is different from the learning situation in high school"(Kartika 35). The academic structure of university that Kartika described is completely different than what most university students had in high school since they will be coming in without any study skills or habits. Fortunately, it is not completely bad news since this new academic structure will give students the incentive to start developing their study skills and routines. Now I want to emphasize that some high schools do prepare their students for college but in most situations, high schools don't really prepare students for STEM degrees.

But why does having study skills make students successful in STEM degrees? We look at the research "Contributions of Study Skills to Academic Competence" written by Maribeth Gettinger and Jill Schurr, both psychology professors, who researched study skills. They both said, "Academic competence is associated with the knowledge and application of effective study skills" (Gettinger & Schurr 350), this explains that you need to know what study skills and habits to use, and how to apply them effectively. Good study skills and habits will help you be successful but it's not only meant for undergraduate STEM students as it applies to anything that you want to learn or even for graduate school. One of my chemistry teaching assistants said she had a friend that made it through undergraduate without studying but when they got to graduate school, they were struggling since they found out they actually needed to study well and had to develop study skills. So not knowing study skills can eventually catch up to you at any moment

of your academic career or any time of your life when you need to learn a topic. Now developing study skills and routines is not as simple as it can be complicated. Gettinger and Schurr talk about the four requirements to have a successful set of study skills listed here:

1. “First, studying is skillful; it requires training and practice with specific techniques that help a learner acquire, organize, retain, and use information.”(Gettinger & Schurr 350)
2. “Second, studying is intentional. Effective studying requires not only the knowledge and application of skills but volition as well”(Gettinger & Schurr 351)
3. “Third, studying is highly personal and individualized”(Gettinger & Schurr 351)
4. “Finally, studying involves a self-regulatory dimension.”(Gettinger & Schurr 351)

These rules specify that to have good study skills, you need to take the time to train and practice some of the skills to learn but also understand what is working and what isn't. But looking at rule 3, studying really depends on the individual and so not all types of study skills and routines will work for everyone. Developing study skills has to be done with intent or having the will to do it. While Schurr and Gettinger's research article primarily focuses on students at all grade levels, such as high school or middle school, the idea can still be applied to college undergraduates majoring in STEM.

To investigate how to develop study skills to succeed in STEM, I conducted interviews with four different STEM students majoring in different fields. The interview asked them questions about the expectations in STEM majors, how their study skills and routine changed, how they currently study, and what advice they can give out. I will also back up the interview results and any important ideas about study skills or any studying advice with secondary

research. Finally, I will discuss some studies that have been done with different types of study skills that can be implemented into your own routine.

Section 2: Methods

To investigate how to develop a good set of study skills and routines to succeed in STEM, I have conducted interviews with four STEM students who are third years since they have already established a study routine and are in different majors to give different perspectives. The students listed below in table 1 will provide valuable insight as they are in their upper division course which means they have developed good study skills and habits.

Table 1

Interviewee	Year	Major	Perspective
Josh Siegel	Third year (3rd)	Biomedical Engineering	Engineering
Stephany Aguayo Uribe	Third year (3rd)	Biosystems Engineering	Biology and Engineering
Yareli Lozano	Third year (3rd)	Clinical Nutrition	Biology
Arlene Peralta	Third year (3rd)	Mathematical Analytics and Operations Research	General Sciences

Now while there are probably hundreds of different STEM majors and it would take up a significant time to analyze all of them, they do overlap. I categorize them into different perspectives which are Engineering, Biology, and General Sciences. Engineering is for anyone The questions I asked them will give me information about the expectations in STEM, how they utilize lectures and office hours, what is their current study routine like, how was their study routine like when they were Freshman in college, and how their study routine evolved, and finally the advice they gave in their survey. The questions on the interview are listed below:

1. What are the expectations needed to succeed in STEM courses from your experience?
2. How do you utilize lectures and/or office hours in your study routine?
3. What is your study routine like? What skills and additional resources do you use that are implemented in your study routine? Skills can be time management or organizational skills and resources can be textbooks or tutoring for example.
4. Comparing your first quarter at Davis and where you are right now, how would you describe your study skills and routine back then compared to right now? What changed?
5. What advice would you give to incoming students about them developing their study skills, and routines, and what to expect as an undergraduate STEM student?
6. Any other advice, comments, or suggestions you would like to mention?

To gain a fifth perspective, I will also give my personal input as an engineering student currently majoring in Aerospace and Science Engineering but I was a Physics major in the past and will be able to give some input in the General Sciences. While I discuss my results in the findings section, I will also back them up with secondary research that has been done on either google scholar and the UC Davis library database.

Section 3 Overview of Interview Findings

After proceeding with our methods, we have collected copious amounts of helpful information from our student interviews. They have shared their experiences of the expectation in STEM, Office hours/Lecture experiences, study routines, and study advice. To go over the comprehensive amount of information gathered, I have split this section into subsections to go

over the interview findings in more detail. These subsections are Expectations of STEM courses, Utilization of Office hours and Lectures, Study Routines, Advice from Interviewees, and Interview Conclusions.

Section 3.1: Expectations of STEM Courses

Josh and Stephany gave their perspectives on general STEM courses such as Chemistry, Math, Physics, and Engineering. For the general STEM courses, both have mentioned that you need to be actively studying consistently, devote a lot of time to your classes, and stay on top of deadlines. These expectations are typically in STEM since classes go faster than the ones in high school and professors cover a lot of material in a short amount of time. With that said, you need to study consistently and devote a lot of time to not fall behind which is easy to do. Now there is one thing that most undergraduate STEM students don't understand but Stephany nailed it in her interview. She has said, "You have to do outside studying and can't just rely solely on lectures and lecture notes to get you through the class" which is true from my experience as well. The reason for this is that in lectures, there is so little time to cover the material that the professor will either rush, briefly, or not properly explain the material but expects you to understand it in exams. This is why you would need to study outside since it is meant to clear up any gaps and reinforce the topics from the lecture. Otherwise, if you just rely on the lectures and the notes you took, it will be difficult to pass or get a grade to your satisfaction.

Engineering is one of the STEM fields where expectations are higher to which Josh explained that "you need to devote a lot more time" to engineering courses. For example, Josh mentions in his interview that he spends about 5 hours per day on his Biomedical Engineering (BIM) 106 class for his major. Josh and Stephany mentioned that in STEM, especially in engineering, you need to be able to do problem-solving and critically think. This is usually the

reason why engineering courses can take a lot of time to study as you need to develop good critical thinking skills to solve difficult problems which take a good amount of time. It is expected to have good critical thinking and problem-solving skills in all fields of STEM. From my experience, the more classes I took in engineering, the more my critical thinking skills improved which had a positive impact on me in the future.

Arlene has given her perspective in the general sciences as Mathematical Analytics and Operations Research major. In her major, she stated, “As a math major, I believe many people assume you have to be good at math but it could also be that you just enjoy problem-solving”. You don’t have to be an expert in the subject but as long as you like it and enjoy problem-solving then you will do okay in the major of your choice. In my experience, I know people who majored in something that they didn’t enjoy and it did hurt their motivation to excel in their field of study. But once they switch to a different STEM major where they enjoyed what they were doing, they started to excel in it. One important expectation Arlene has mentioned is asking questions. She states “asking questions is essential in succeeding in these courses as the concepts become more and more difficult every year”. Arlene makes a good point since, in STEM courses, you are most likely going to be confused about something so the expectation is that you need to be able to ask questions. The most misconception that some people say is that “if I have to ask questions, I am not smart enough”, which is not true since people don’t succeed without getting help in some way. For me, if I get stuck, I always ask the professor or teaching assistants(TAs) for questions during office hours.

Yareli and once again Stephany gave some of the expectations from the Biology perspective. Yareli explains that her major is heavy on chemistry and she says that an understanding of basic chemistry knowledge is expected if going into the Biology area. Stephany

also mentioned that in Biology, you can't just memorize everything, you need to understand the how and why of the different topics in Biology and it's always easier to visualize things. So in Biology, it's expected for you to understand the basic chemistry knowledge, understand the how and why in concepts, and be able to visualize things.

Section 3.2: Utilization of Office Hours and Lectures

Lectures and office hours can be one of the most useful assets to utilize in your study routines depending on the situation. Now while it was mentioned that you shouldn't rely on lectures to teach you everything, it doesn't mean that they're useless. Most of the time lectures will introduce you to topics for the course which can help you plan out what to study outside of class instead of you figuring it out on your own. For example, Stephany says "I use the lectures to understand the topics covered and emphasize doing additional outside studying but if examples were covered then you should pay extra attention to it to learn the structure of the question/material". What Stephany does is probably one of the best ways to utilize lectures since missing them can cause you to be confused about the current material until you get caught up. I did miss a few lectures in the past and it did hinder my ability to complete assignments. I had to learn the material to get caught up which wastes my time focusing on other classes.

Office hours can be one of the most useful resources, especially for STEM courses since the professor or TA can help you understand the material or get through the homework. But people use office hours differently, for example, Josh said he would "find a good professor or TA and go to their office hours which is how I made it through in my courses". Primarily office hours can be used commonly in other ways. For example, Stephany and Arlene would go to office hours to ask questions or receive help on the assignments that they attempted or concepts they don't understand. But office hours can have another purpose besides just asking the TA or

professor for help, they can also be used to meet your classmates or even people within your area of study. Yareli mentions that she would “work on homework/problems with my classmates or get help from the TAs” and this can help her form study groups for the course or future courses.

Section 3.3: Study Routines

As previously mentioned, most incoming college freshmen have very minimal study routines and most of them will get grades they don't like whether they passed or not. Josh mentions in our interview that “My first quarter at Davis, I never really studied but I passed my classes but never really liked the grades I earned”. Similarly, Stephany also mentioned that she attended tutoring sessions in her first year at Davis, she would use the sessions to teach her the concepts instead of learning them on her own. The tutors would help her but she admits that this was not the best way to learn and did not achieve the best grades she had hoped for. I can relate to Josh and Stephany's situations since when I was also a freshman during my first quarter at Davis, I didn't really know how to study which led me to receive grades I did not like.

Observing the results from my interviews, all my interviewees did say that their study routine varies depending on the course. For example, Josh and Stephany have mentioned that classes like Biology or Neurobiology, Physiology, and Behavior(NPB) would require you to understand the readings and concepts but sometimes you do need to memorize some ideas. But for other classes that require problem-solving, such as engineering/physics/chemistry classes, both of them mention that doing practice problems and understanding them is key. The reason for this is because you want to be able to test yourself without looking at the solutions and if you can solve the problem correctly then you are in a good position to do well on the exam. While doing practice problems from the textbook is a good way to prepare for the exam, sometimes instructors will post practice exams, and doing them is important not only for the additional

practice but you can understand the style and how they write their exams. One good routine Josh has is that he would go to his TAs during their office hours where he would receive help or clarification with his assignments. But he also talks to the TAs and asks what are some things that would be emphasized for the exam. Josh says this method can be helpful since he says “they might give useful hints”. It's **IMPORTANT** to mention that you don't ask the TA what will be on the exam directly. But once they emphasize something, you can ask them to go over a problem they hinted about. A common response from my interviewees is that it is a good routine to utilize textbooks as a secondary resource Utilizing the textbook can help you clarify some topics in the course or cover some example problems. This routine can help improve your study habits depending on how you utilize the textbook.

Section 3.4: Advice from Students

My interviewees gave me some good advice on some insight on how to do well in undergraduate STEM. A common piece of advice I got was that you shouldn't employ your study habits from high school since from their experiences, they didn't need to study as much to do well in high school. When they started university, they quickly realized that the habits they had in high school were not sufficient to do well in university courses. As previously mentioned, university courses move extremely fast and there isn't enough time for the instructor to cover everything. Therefore, it requires you to have developed study skills and habits for you to be able to not only study in the classroom but also outside of it. Josh and Yareli's advice for incoming students is to use some kind of planner where you can stay organized and be aware of deadlines while being able to keep track of anything important. The reason for this is that so much goes on when you're a college student and it's easy to forget or get distracted by what needs to be done.

Having a planner to help you keep track of your weekly schedule can make sure you stay organized which is probably the foundation for developing good study habits.

Time management is an important skill to have in developing good study habits. Stephany mentions that college is really fast-paced so it is important to manage your time but one important thing she emphasized was that you shouldn't always make school your life all the time. She talks about how you should make some time to take care of yourself by either having breaks, socializing, or doing anything that makes you happy. This advice is worth mentioning because it's really easy to get burned out from school and not keeping a clear head can impact your performance in your classes. When I study, I set aside a few hours a week to either do self-care or something fun with friends. This helps reset my mind which allows me to focus on course performance significantly. For example, whenever I was struggling with a homework assignment and after a while of not being able to figure it out, I would take a break, and coming back to it later I would be able to make good progress later on. But it's important that you manage your time properly since if you have an assignment due in hours then it is hard to utilize this method.

Section 3.5: Interview Conclusions

After my interviews with Yareli, Josh, Arlene, and Stephany, they provided some insightful information that I was able to relate to. While the STEM field can be challenging, it is still doable to do well in your particular field and have a well-rounded college experience. Going to lectures is an important foundation for academic success but as previously mentioned, lectures shouldn't be your main source of learning but it is a piece of the puzzle. Going to office hours or tutoring when you need help and knowing how to self-study can help you go a long way to being successful. While academics are important in university, you shouldn't make it your whole life until you graduate. You should always incorporate a mix of non-academic activities in your life.

Taking care of your mental health is important and you can do this by doing hobbies you enjoy, watching movies, joining fun clubs, or socializing with your friends. To manage all of this, the key skill to learn is how to manage your time properly which is easier said than done,

Section 4: Relationship Between Study Time and Effectiveness

From my findings section, I want to dive deeper into time management but specifically on the relationship between time spent studying and effectiveness. Looking at the research paper “Performance of College Students: Impact of Study Time and Study Habits” by Sarath A. Nonis and Gail I. Hudson, gave some helpful details on how time, study efficiency, and academic performance are related. The paper has mentioned that “quantity of study time has on academic performance was expected to be stronger for students who use good study habits more often compared to those students who use them less often”(Nonis & Hudson 231). This keynote from that citing is that your study habits play an important variable along with how much you study. From my experience, I would hear people say “I have studied for two weeks on this exam and still failed, how is this possible?”. There are usually two reasons that play into this. The first one is, for example, if you spend 60 minutes studying but spend 40 minutes just going on your phone, then you only really studied for 20 minutes. The second factor, the one I will go into more detail about, is that you might have been studying for the whole hour but the methods you have used may not be as effective for that particular course.

The idea of people thinking that the more I study, I should receive a high passing grade is just simply not true all the time but there are certain conditions. As mentioned above, some people might have a higher quantity of study time but their quality of studying might have been lacking leading to poor academic performance. The ideal condition is to have high-quality study habits but also have a high quantity of study time which can lead to students having the best

possible outcome for academic performance. Supporting this idea, the same article from Nonis and Hudson mentioned that “truly studying may not simply be a quantity issue; there are qualitative techniques, such as good study habits, that can make study time effective for students”(Nonis & Hudson 236). To summarize the end of their article, no matter how much time you spend studying, if you can not focus or study effectively then your academic performance will go down.

As previously mentioned, the condition for the best academic performance is having a high quantity of study time and high quality of studying is the ideal case. The problem is that we are assuming that students have an unlimited amount of time and don't have other responsibilities outside of class which is simply not true since students need to eat, sleep, relax, work, and maintain other commitments. An article by D. E. Ukpong & I. N. George titled “Length of Study-Time Behaviour and Academic Achievement of Social Studies Education Students in the University of Uyo” where one of their recommendations on helping students improve time management for academic success states “Students’ should develop good study habit in order to understand how long he/she can study for an effective outcome.”(Ukpong & George 176). To understand how you should develop your study habits and correlate that to study time, there are several factors to consider. These factors are understanding your strengths and weaknesses, what type of class you are dealing with, and what kind of schedule you have in your current term. For strengths and weaknesses, you should think about what you excel at, such as whether you are good at solving mathematical calculations or are you good at writing technical papers for projects. Vice versa, if you struggle with writing papers, doing calculation problems/memorizing information for exams then you might spend more time studying. So understanding the structure of the class you are in plays an important role in whether the class

plays into your strengths or weaknesses affecting your study time. Sometimes these types of courses do require heavy critical thinking and usually, the best way to improve your critical thinking skills is by practicing solving problems and understanding the material you are learning. Another factor that plays a role in study time is the content the class is covering. For example, some people can understand Biology easily but may struggle in understanding physics and therefore might need to spend more time with physics concepts.

Taking these into consideration should help you figure out how much time you will need to put into a course to be successful and manage your time properly. Once you have all these factors in your consideration, you will need to look at your schedule for the term but you need to consider other things besides your class schedule. You might need to look at outside commitments, how long will your commute take, and possibly any type of work you might have but these are just to name a few. Once you have a good overview, this should allow you to see if you need adjustments in your schedule if needed.

Section 5: Summarizing Good Study Practices

Now while there are plenty of good practices, we will cover some of the common ones that suit most people. Professor Marty Lobdell wrote a book titled “Study Less, Study Smart: How to spend less time and learn more material” where he provides valuable rules on effective study techniques. I will use Lobdell's book for the majority of this section as he provides valuable information. Along with his book, I will also use other research articles mentioned in previous sections to support Lobdell's rules since they also provide good additions to study techniques.

The first rule from Lobdell is that he states “when you feel that you are not learning efficiently, take a break and reinforce your studying behavior”(Lobdell 7). This rule emphasizes that taking breaks is important as if you study non-stop, you will eventually stop learning efficiently. So when you take breaks, it allows your brain to reset and helps you learn efficiently. Lobdell states that the average student will be able to learn material for 20 to 30 minutes before their learning efficiency decreases and he mentions that taking 5-minute breaks in between can reset the mind for learning(Lobdell 7). Another justification for why taking breaks is important, Lobdell says “To continue trying to study, if you are not learning efficiently, actually punishes your attempt to study. You feel bored, listless, and discouraged which makes you less likely to want to study in the future.”(Lobdell 7). Lobdell makes an excellent point since this is something my friends and I would experience. We would spend a lot of time studying together to the point where we are not absorbing the material and we get frustrated when we start disliking studying. When I learned this rule from Lobdell, I started taking breaks when I feel that I am not learning anything or I am stuck on a problem I couldn’t solve at the moment. In the case where you can not solve a problem that you are working on, this is a good point to seek help from classmates or your instructor. The only thing is that you need to manage your time carefully as doing any assignment or studying for an exam at the last minute will reduce your options to look for help or understand the concepts you are studying.

Lobdell's rule 2 states “ create a study”(Lobdell 9) which by that means you should set yourself in an environment where you can study without distractions. This is another rule that I consider to be vital to be successful as if you try to study somewhere that is not meant for studying can be a distraction. An example would be studying in the bedroom or kitchen where you can possibly sleep or start snacking on food instead of studying respectively. In my daily

routine, I would get to campus in the morning usually and would stay there until nighttime. So while I am on campus, I would find an environment where it is set up well for studying and attending lectures or labs as needed.

To add to this topic, the research article by Ukpong and George wrote another recommendation that states “Students should set a study timetable and stick to it”(Ukpong & George 176) as setting up a study schedule and sticking with it as much as possible will help you pace your studying.

To finish off this section of good study practices, Lobdell had two more rules where he states “Rule number 5: discover the meaning of what you are studying. Rule number 6: whenever possible engage in deeper processing.”(Lobdell 13). Lobdell is trying to explain that you should be learning the material on a deeper level and not just on the surface to just pass the class especially if the course is a prerequisite to another. Often times students would just learn the material just to get through the class but not hold on to most of the knowledge afterward. For example, if a student was taking a calculus course, they might know how to solve calculus problems but not necessarily know the purpose of calculus. Nonis and Hudson also stated in their study that “students using the deep approach had a significant, positive relationship with their course grade, whereas students using the surface approach had a significant, negative relationship.”(Nonis & Hudson 230) which shows that whenever you are trying to go for the deeper learning, it can help you on your course grade and even your future courses where the knowledge will stack up.

Conclusion

As we learned, most students who enter university as STEM major usually experience academic difficulty due to a lack of study skills and habits. This usually leads to students earning grades they are not satisfied with and in some cases, they might even leave the field due to this issue. Students have learned to build their study skills up over time and thus their academic performance would generally increase. An important finding is that students who have effective study skills tend to perform academically better than students who spend more time studying with less effective methods. This is not to say that the amount of time spent studying is not important but depending on how you use your study skills, the amount of time spent studying might vary. While studying for academics is important as a college student, it's also important to look at other things that play a role in academic success indirectly. Maintaining a solid academic and non-academic life balance plays a huge role on top of learning study skills which leads to students leaving university with successful academic performance.

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