

Enriched Student Guidance and Engagement in Lower Level Engineering Gatekeeper Courses

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Abstract— In many engineering programs, students are usually provided support and guidance to proactively engage and overcome challenges to discover ways to succeed in lower level gatekeeper and subsequent courses. In various instances, these early interventions point to needs of addressing issues about effective student academic engagement (i.e. helping students to work smart) to promote long lasting effects. The main goal of this study is to enrich current early interventions by providing students with guidelines to develop skills and study habits and to implement study practices to promote academic and professional success. The early intervention with enriched student guidance, described in this paper, is organized around key gatekeeper courses with failure rates (i.e. D, F, or withdrawal) that often exceed 30%. The early intervention includes the identification of at-risk students and the implementation of a student support program. In order to develop successful independent learners, the intervention has been enriched with the promotion of best study practices. Students are informed about expectations and guidelines to become engaged in the course, to understand its support structure (e.g. office hours, peer-led mentoring, homework format, note taking, time management, online assessments, building communities, and others), and to take responsibility for their own educational success. As part of the course grade, students are accountable to implement best study practices by maintaining a well-organized course binder and using services such as peer mentoring and office hours, and to follow guidelines to keep up in the course. An online survey to determine students' judgment about the importance and impact of the guidelines, expectations, and engagement activities in the gatekeepers was implemented and the results are presented in this paper. It is also expected that the results of this study could help instructors to determine the best structure of gatekeeper courses to guide students to develop the skills required in Engineering.

I. INTRODUCTION

This study focuses on lower-level engineering gatekeeper courses in order to provide students with guidelines and information to promote successful independent learners with best study practice skills in these as well as in subsequent courses. In particular, the results presented in this study were obtained in the Statics course for Mechanical and Civil Engineering majors. Statics is one of the first fundamental engineering courses in almost all engineering careers; and students in Statics need to acquire a strong foundation of long-lasting knowledge, a deep understanding of concepts, and

mastering techniques and procedures essential to analyze and solve engineering problems. Statics begins with an explanation of the syllabus, followed by review and assessments of prerequisites. Based on the assessment results, students were advised to review prerequisite material, at-risk students were identified, and interventions were performed to encourage best study practices to improve knowledge integration, retention, and passing rates. At-risk students are considered to have higher failing probability of lower level gatekeeper courses. The next section describes at-risk student identification and common best study practices being promoted to guide students to be successful learners.

II. AT-RISK STUDENTS AND PROMOTING BEST STUDY PRACTICES IN STATICS

The authors of this study have found that the Statics course passing rates depend on several factors such as prerequisite preparation and knowledge retention, which has been determined by online assessments and pretest results at the beginning of the course (i.e. prerequisite knowledge is a good predictor of student success in the Statics course) [1]. Students from multiple backgrounds get to Statics with prerequisites approved in the summer or in regular semesters, at the university, high school, dual-enrollment, or community college, with online exams, multiple-choice exams, or with written exams, among other possibilities. It has been observed that in recent semesters due to interventions, including challenge-based instruction and peer mentoring, improved passing rates and a significant increase (~10%) in the number of students receiving final grades of A or B have resulted. However, it has also been determined that some students drop the course along the semester due to different circumstances including deficiency in algebra and trigonometry, heavy workloads, too many courses, missing homeworks and classes, and a lack of commitment to be persistent and overcome frustrating experiences. Besides, one of the main difficulties students face in Statics is retention and integration of knowledge to develop adaptive expertise skills to apply the learned concepts and procedures in solving a diversity of engineering mechanics problems in an organized, comprehensive, and clear way [1]. In our department, the passing rates in Statics taught by different instructors was about

60% from 2006 to 2013. However, the passing rate in the Spring 2014, Fall 2014, Spring 2015 and Fall 2015 were 75%, 71%, 61%, and 71%, respectively (including students who dropped), and the improved results coincide with peer mentoring and other intervention efforts presented in this paper.

Diagnostic testing has become more widespread in colleges and universities [2] to identify at-risk students, which is especially relevant for lower-level engineering students [3]. Such students are more likely to need additional measures to enhance their achievement while upper-level students are more likely to take actions to compensate for deficiencies in prerequisite knowledge [3]. Some studies have suggested combining student past performance with retention of prerequisite knowledge and ongoing performance in the course to identify at-risk students. For instance, in dynamics, the most useful predictor variables were estimated to be the GPA, three prerequisite course grades, and the first exam score in the course [4]. Steif and Dollar [5] developed a learning computer system in Statics to track on-line learning activities and to estimate students' needed skills and concepts. Another study used the organization of student's solution to problems in Statics to correlate to the correctness of the work and as indicator of at-risk students [6], [7]. In addition, the perception of engineering, motivation, confidence, competency, retention, and persistence of students is affected by their attitudes and self-assessed abilities [8]. Many students need self-monitoring skills to figure out their own responsibility required to obtain an engineering degree. Some students lack certain skills and level of maturity (e.g., time management and communication skills) that instructors might take for granted [8]–[10]. Bandura [10], [12] defines self-efficacy as “people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives”. Increasing self-efficacy for a specific challenge is expected to have a direct impact on achievement [13].

There is evidence that the process of selection, implementation, and optimization of early educational interventions is not trivial. The self-regulation required at the college level is frequently not what students are used to. Instructors must encourage students to develop best study practices to master knowledge and understanding to succeed in the courses. Early educational interventions are especially important at lower-levels and the literature suggests that by improving the performance, during the first term, of students at risk, the chance of successful completion of the engineering programs increases [14]. Supplemental instruction for at-risk students has been found to be effective in improving the grades of such students [15], and it is recommended with qualified and trained peer mentors that do not work problems for students, instead, they teach students how to learn. Many students do not know how to envision themselves as learners, self-monitor learning, set goals, and actively apply strategies [16]–[19].

III. BEST STUDY PRACTICES IN EARLY STEM COURSES

Authors hypothesize that to further enhance student success in gatekeeper courses as well as subsequent courses, best study practice skills needed to be presented or reinforced. The

research question in this paper is about the student opinions in gatekeeper courses about common documented best study practices that might determine their academic success. Authors employed a mixed method approach of quantitative (pre/post surveys) and qualitative data (student comments) obtained online through Blackboard. It is expected that students take ownership of their own learning process by reviewing these guidelines and expectations at the beginning of the gatekeeper courses and follow them throughout their career. As an enrichment components of the interventions in gatekeeper courses, the authors developed expectations and guidelines for students to get familiar with and implement best study practices in the gatekeepers as well as in subsequent courses, such as:

- Written and online homework and solution format;
- Time management recommendations;
- Prerequisite material review and pretest preparation;
- Class attendance, note taking, working on class notes and keeping an organized binder/notebook;
- Preparing for and attending office hours and peer mentoring sessions; and
- Using the syllabus.

Figure 1 illustrates important areas in which students in gatekeeper courses need clear expectations and guidelines to develop good-learner skills and habits.

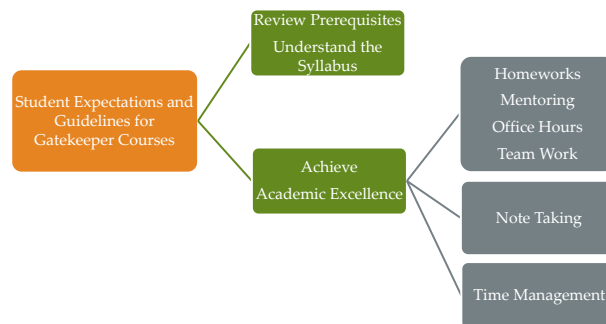


Figure 1. Expectations and guidelines for students in lower-level STEM gatekeeper courses

A. Homework Guidelines and Problem Solution Format

Homework and assessments that students complete on their own, or with peers, are one of the most important activities in their learning process. By doing homework, students get to practice solving problems and get formative feedback useful to determine concept understanding or the need to look for assistance. Students need to start homeworks as soon as possible to study class notes and the material in the textbook, to attempt them multiple times and have enough time to ask questions. It is recommended that students follow the next homework solution guidelines:

- Each homework solution needs to be identified with a title and date.
- When homework is online, solve the problems on paper and keep all written work in an organized binder or notebook.
- Keep work done in attempting to solve the homework and any questions to ask for help.

- If online homework allowed multiple attempts, students should try to get the best possible grade by trying it numerous times; that way, they practice more and become better prepared for exams.
- Once students get the graded homework back, it is a good practice to study any feedback and understand any mistakes to avoid them in the future

Figure 2 shows an adequate set of steps to solve homework problems for students to test their knowledge and develop deep understanding of the application of such knowledge.

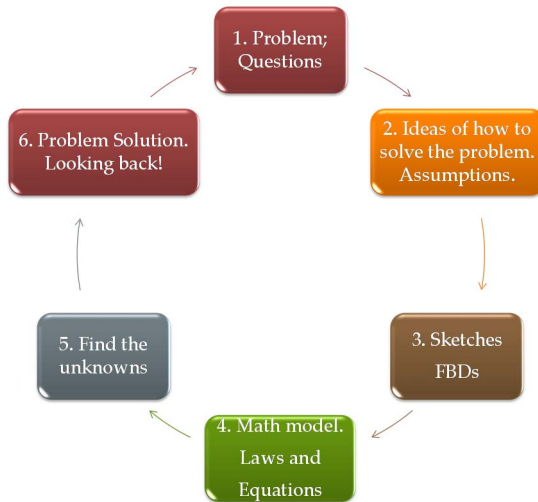


Figure 2. Solution procedure to homework problems

Figure 3 illustrates a six-step procedure to solve an example homework problem. Instructors are encouraged to provide students with sample problem solutions using the required format to present their work. Notice that the procedure calls for indicating the problem statement, assumptions, making sketches (diagrams or FBDs), using math models with physical laws, and solve the equations indicating steps and substitutions, to find the answer and to reflect back to determine if the solution makes sense and if there are other ways to solve the problem. Students that work in an organized way and follow these steps in the solution of problems are usually able to clearly communicate their knowledge and demonstrate deep understanding of the subject.

B. Professor's Office Hours and Mentoring Sessions

Students are encouraged to look for help during the instructor's office hours with the following recommendations:

- Clarify any class notes or important steps missing or in need to understand better to solve problems.
- Acquire help and guidance and let the professor know interest in mastering the material.
- If working in groups, several students can visit the professor during office hours and ask several questions at the same time.
- After studying and attempting to solve problems, prepare any questions and bring work, textbook, and class notes when attending office hours or mentoring sessions.

Step 1: Problem Statement

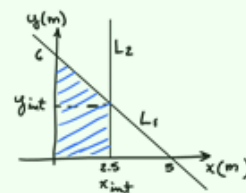
1- Determine the area of a steel plate represented by the shaded area in the figure.

Step 2: Ideas of how to solve the problem. Assumptions

The shaded area can be divided into common shapes whose areas can be individually determined and added. Assumptions: the shaded area can be divided into a triangle and a rectangle whose dimensions can be determined. There are several ways to solve the problem.

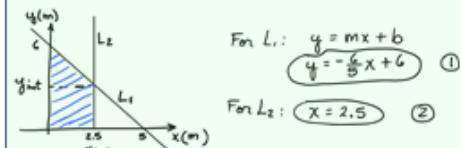
Step 3: Sketches and free body diagrams (FBDs)

3. To solve the problem, we need to find the intersection of lines L_1 and L_2 .



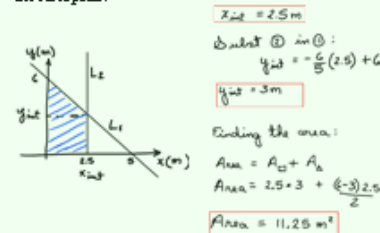
Step 4: Mathematical model. Laws and Equations

4- Determine the equations of lines L_1 and L_2 .



Step 5: Find the unknowns

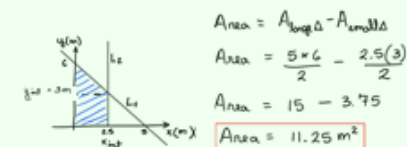
5- Determine the intersection of lines L_1 and L_2 and the area of the steel plate.



Step 6: Problem Solution. Look back.

6- The area of the steel plate is 11.25 m^2 .

Looking back: are there other ways to solve the problem? Is there an easier way to solve the problem?



It seems that there are several ways to solve the problem and all of them require to find the intersection of lines L_1 and L_2 .

Figure 3. Procedure to solve homework problems

In addition, students are encouraged to attend peer mentoring sessions. A peer mentor is a selected qualified upper-class student that has successfully attained understanding and knowledge of a subject and is willing to help others going through a similar learning process. Peer mentors could help students serving as resources for academic issues, assisting in developing skills, and assessing and supporting new thoughts and ideas [22]. Peer mentors can help students with study strategies, techniques to learn, organize, and understand the information that is presented in class and in the textbook; and engaging them to learn, without doing their homework. The following recommendations were provided to the students with respect to peer mentoring [23]:

- Students are expected to actively participate and work hard to improve academic or study skills and a commitment to be responsible in preparing and attending peer mentoring sessions is expected.
- Students are expected to study the textbook and class notes and try as much as possible to solve the assignments before attending mentoring sessions.
- Attend mentoring when you need some assistance with course content or assignments.
- Student responsibilities to attend mentoring sessions:
 - attend classes, be accountable, reliable, and consistent;
 - bring course syllabus, class notes and materials, and textbook;
 - bring the assignments and solution attempts, complete the assignments as much as possible;
 - bring list of questions and concerns; and
 - share expectations with peer mentor and look for friendly encouragement and guidance.

Peer mentoring sessions are recommended for the following reasons [24]-[26]:

- To obtain help to understand, clarify, and solve assignments or lecture examples;
- To get guidance in developing ideas on how to solve problems;
- To get help to determine your learning style;
- To help develop communication, study, and personal skills;
- To develop time management skills and learn study strategies;
- To identify goals and establish a sense of direction becoming more aware of the next career stage;
- To become more empowered to make decisions and increase social and academic confidence; and
- To get experience to become a future mentor.

Students might have wrong expectations during mentoring or office hours. During office hours or peer mentoring, students should not expect [22]-[26]:

- To get lecture information missed by being absent or late to class without appropriate justification,
- That the professor/mentor do all the steps in the solution of a problem students are supposed to solve,

- That the student sit and solve problems during office hours and the professor/mentor would be looking at the process at each step to see if it is correct, or
- The student would not be asked questions and to work hard to solve the problems.

In addition to guidelines for attending office hours and peer mentoring sessions, students are also encouraged to form a learning community and study group [27]:

- Organize study sessions to complete assignments; every student needs to be responsible by studying the material and the problems before getting together.
- Avoid situations where some members of the group are not doing their part.
- Help each other and motivate each other to study and learn.
- Benefit all involved if everyone participates and follows rules; avoid wasting time that was supposed to be productive to study and learn.
- Reinforce the understanding of concepts by explaining them to other students.

C. Note Taking during Lectures

Additional guidelines are provided to the students with respect to note taking because:

- It is common that students understand what the instructor is doing; but, later on, they cannot remember how to do it on their own.
- Students should not rely merely on their memory to remember lecture material.
- Taking notes helps staying focused on what the instructor is presenting.
- Keeping record of important information is useful to studying later for exams and in future courses.
- Class notes are needed during labs, study group sessions, peer mentoring sessions, and office hours.

Be prepared to take notes in class and to rework them and keep them organized:

- Date and add a title to your notes:
 - Take key notes and write down examples explained in class.
 - Write down all examples and the procedure used by the instructor to solve the problems.
 - When appropriate, use abbreviations and acronyms, coined sayings, or interacting images.
- Prepare before class by studying the textbook and reviewing the class notes from previous lectures.
- It is a good practice to rework the class notes and keep them in an organized binder or notebook.
 - Associate new ideas/concepts with other things you already know.
 - If it is a new concept, develop an understanding by analyzing the information and comparing it to the textbook information.

D. Time Management

The following are guidelines provided to the students with respect to time management:

- For a typical week in the new semester, prepare a detailed schedule, include class time, work hours, study hours, etc. During each week, create a list of things you need to do and prioritize them.
- Attend all classes, take lecture notes, and pay attention to the professor's lectures.
- Start working early on homework and assignments and complete them; and if you need help, attend office hours, mentoring sessions, and/or form a study group to help each other.
- Use a calendar to indicate important exam dates and due dates for projects or other assignments in the semester.
- Make a to-do list regularly and plan to complete them without procrastination.
- Focus when studying class notes, reading the textbook, and completing assignments; avoid wasting time on things that are not important for your courses.
- Take short breaks every hour or so when studying for long periods, this usually helps to continue studying longer and to learn more.

Figure 4 shows the time management considerations that students should take into account when organizing their schedule.

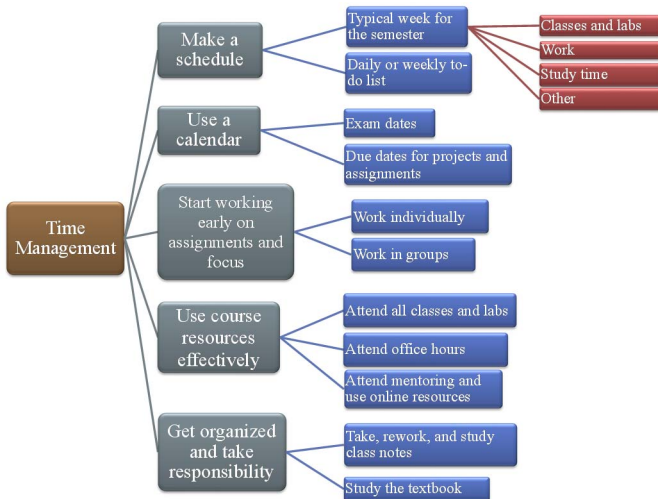


Figure 4. Time management considerations

E. Syllabus

The syllabus is an important document that includes the evaluation criteria, policies, and general and specific information about the course and the topics to be covered. The syllabus is a type of agreement between the students and the instructor. With the syllabus, students get a first impression of the instructor's concerns and interests for them to become involved in the course to learn and understand the material in the course and to support their efforts to succeed [20]. Students

should use the syllabus throughout the semester and follow the rules and information provided therein. Important information in the syllabus includes [21]:

- Instructor information: e-mail, phone, and office hours
- Course materials: books, webpages, online platforms like Blackboard
- Student learning outcomes and what students will learn and for what reason.
- Course procedures: lectures, labs, mentoring times.
- Assessment and grading: grading scales, percentage distributions, policies for incomplete or missing assignments, participation, teamwork, etc.
- Other course policies
- Additional resources: mentoring, tutoring, and online
- Tentative course calendar: dates with lecture topics, textbook sections to be covered, and dates for exams.

The following section presents the student opinions about the expectations and guidelines provided to them in the gatekeeper courses.

IV. RESULTS OF SAMPLE INTERVENTION AND STUDENT OPINION ABOUT BEST STUDY PRACTICE GUIDELINES AND EXPECTATIONS

Instructors in gatekeeper courses often sense a lack of organizational, time management, and communication skills of some students. At awkward timing, some students ask Instructors about the date and material for the next exam, homework due date and solution format, and the schedule for office hours, mentoring or tutoring sessions; additionally, some students' use poor excuses for missing lectures or assignments. Hence, in this gatekeeper course, the authors assigned a homework at the beginning of the semester through short online presentations (available on Blackboard), in order for students to read and understand the best study practice guidelines and expectations as presented in the previous section. The authors consider the following best study practices essential for students to succeed in engineering:

- Time management,
- Office hours and peer mentoring,
- Note taking during class,
- Homework and required solution format, and
- Using the syllabus.

The assignment consisted of reading the information about these five important study practices posted on Blackboard and as presented in the previous section. After that, they were asked to rank the study practices in the order of importance to be successful in the course. The responses of 42 students were obtained. Table 1 shows that there are all types of opinions with some students considering each of the best study practice to be the most important or least important. It is significant that a large percentage of student consider time management as the most important and usage of the syllabus as the least important study practices. The last rows in tables 1 and 2 show that, using an scale of 1 as the most important and 5 as the least important, at the beginning of the semester students ranked time management at 1.83 as the most important, followed by 2.62 for homework and required format, 2.81 for note taking during

class, 3.71 for office hours and peer mentoring, and 4.02 for the usage of the syllabus. At the end of the semester, students ranked time management at 2.30 as the most important, followed by 2.43 for note taking during class, 2.54 for homework and required format, 3.74 for office hours and peer mentoring, and 4.09 for the syllabus. This means that by the end of the semester, student considered time management, note taking during class, and homework and required format as the most important study practices and at about the same level of importance, while the office hours and peer mentoring was considered a less important study practice and the last one was the usage of the syllabus.

Table 1. Ranking of best study practices at beginning of semester

	Time Management	Homework and Required Format	Note Taking during Class	Office Hours and Peer Mentoring	Syllabus
Most important	62%	12%	7%	5%	14%
Second	7%	43%	31%	10%	10%
Third	19%	21%	43%	17%	0%
Fourth	10%	19%	12%	48%	12%
Fifth	2%	5%	7%	21%	64%
mean (std)	1.83(0.23)	2.62(0.33)	2.81(0.45)	3.71(0.76)	4.02(1.36)

Table 2. Ranking of best study practices at the end of the semester

	Time Management	Note Taking during Class	Homework and Required Format	Office Hours and Peer Mentoring	Syllabus
Most important	51%	20%	17%	0%	11%
Second	9%	40%	31%	11%	9%
Third	14%	26%	34%	23%	3%
Fourth	20%	6%	14%	46%	14%
Fifth	6%	9%	3%	20%	63%
mean (std)	2.30(0.24)	2.43(0.29)	2.54(0.37)	3.74(0.72)	4.09(1.31)

At the beginning of the semester, students were asked for opinions about what they are doing, what they can do better, and what they learned about the suggested best study practice guidelines and expectations. Some selected and representative students' opinions are presented in Tables 3 through 7. Note that students are already doing something about each one of the suggested best study practices. However, it would be incorrect to assume that they know all the information provided in the guidelines, because they have also indicated numerous activities they can do better, and identified new (to them) study practices that they could implement to improve learning.

Table 3 presents the students' opinions about homework and problem solution format. Without homework guidelines and a required solution format, students do not communicate their work in a comprehensive way for the instructor and others to understand. They miss steps, do not draw complete and correct FBDs, do not indicate assumptions, do not indicate the answers and/or the units. Common issues expressed by the students were in the areas of avoiding procrastination, to organize work with detailed sketches to facilitate reviewing and/or studying, and asking questions. It can also be concluded from table 3 that time management and organizational skills play a big role in homework completion.

Table 3. Student opinion about homework

Homework and Required Format		
Make a positive comment of what you do about the "Homework and Required Format", another comment about what you could do better, and indicate something you learned from the provided information about this topic.		
Something you are doing now	Something you can do better	Something that you learned
For homeworks i just do them on the day they're due.	work on them at least a few days in advance	to do homework with enough time to ask questions.
I make sure to completely understand what I am doing before moving from step to step on a homework problem	I tend to procrastinate a lot, so it would be wiser for me to stop procrastinating.	if you procrastinate, you might not have time to actually think and solve problems at a comfortable pace.
I have missed several homework assignments, all because I decide to do it at the end	keeping everything organized with titles and dates so I can go back a review it for when it is needed	review the homework a little more once it is already graded to study any feedbacks and make corrections.
doing all the homework given to me without missing any.	doing all of my online homework on paper to get a better understanding of the material.	Something I learned from this topic was the "Homework Solution Steps"
I do homework the day it is due.	do it a couple of days earlier in order to review my steps with someone or ask for help if I am having trouble	homework is extremely important because it offers practice in the subject that can help you be even better prepared for a test
When I am doing homework assignments online I always write them down in my notebook	Using a title and date on all my notes and homework assignments will keep me organized and more efficient when I plan to review.	By completing homework assignments properly, as stated in the guidelines, I will be able to achieve a "big" chance of success in this course.
doing my homework on graphing paper, putting it in my binder, and understanding the steps I took to get the answers on the question.	draw more detailed sketches of the homework problem, and analyze each step	homework is an excellent way to prepare myself for the exams and quizzes held throughout the course.
I do all my homework on paper and put it in my binder with the section title and homework problems.	Before a test I should go over the problems in the homework and quizzes that gave me the most trouble	I need to make it a habit to check the validity of my answers and double check my work for minor errors.
I rewrite each homework so it looks nice and neat.	Something I can do now is doing homework ahead of time so I can ask questions in case I need help.	Something I learned about doing homework is that there are steps that can help successfully understand and complete assignments.

Table 4 shows some of the students' opinions about what they learned from the guidelines to improve syllabus usage. Some students appreciate the detailed scheduled activities for the course and all the information in the syllabus and actually use it throughout the semester. On the contrary, other students perceive the syllabus as a document they get the first day of class but that is not needed afterwards. Common topics discussed by the students include the importance of knowing grading policies and information that may facilitate academic success (e.g. prepare in advance for lectures).

Table 5 presents some of the students' opinions about what they learned from the guidelines to improve time management. Common topics discussed by students include the importance of making a daily schedule with work and study hours, need to develop project management skills, and the need to develop effective study groups.

Table 4. Student opinions about the syllabus usage

The Syllabus		
Make a positive comment of what you do about the "Syllabus", another comment about what you could do better, and indicate something you learned from the provided information about this topic.		
Something you are doing now	Something you can do better	Something that you learned
saves me time and keeps me informed on what topic will be cover on specific week, exams dates, professor contact (email, phone, office hours), textbooks, etc.	The syllabus gives ideas on how to be successful in the course.	Something that I learned about this topic is to print the syllabus and keep it on my binder.
I always keep a copy of the syllabus with me in case i need the professors information or need to look at the schedule.	I should read the syllabus completely instead of only putting focus on the schedule and grading rubric.	I learned that the syllabus is a great way of getting the first impression of your professor.
search the e-mail for the professor, the office hours that he is available, and the book or any other account on line that we will be needing for the course.	Something I can do better is to fully read the Syllabus and understand all the policies that are set.	Something I learned was that the Syllabus is a very important tool to help us throughout the semester to be successful.
At the beginning of the semester I make sure to read the syllabus thoroughly.	It would be better if I printed out the syllabus to every "course" and have them in a binder.	I learned that a syllabus can have additional resources
using the schedule given to plan for tests and reviews which I can use to prepare for exams.	using it not only for exams, but to prepare for lectures and get ahead on topics that will be covered in class	begin using all the resources that are listed in the syllabus like office hours or additional help which can be provided when I am stuck on a problem.

Table 5. Student opinion about time management

Time Management		
Make a positive comment of what you do about "Time Management", another comment about what you could do better, and indicate something you learned from the provided information about this topic.		
Something you are doing now	Something you can do better	Something that you learned
I check blackboard and the syllabus every week and any emails having to do with homework so that I could be aware of what I have due for that week	I tend to procrastinate a lot, so I really need to stop that and manage my time more effectively.	it is recommended to take breaks every hour or so when doing homework or studying for long periods of time.
I tend to keep up with test dates, I check blackboard and the syllabus I tend to get prepared a few weeks in advance for the up coming test	i have been lacking in keeping up with assignment dates, I have a really bad habit in leaving everything until the end	make a to do list every week and have a calendar with me at all times to write down important dates.
check calendars with due dates for my assignments and exams so that I can set enough time to work on them and study.	keep schedules and set specific amounts of times at specific dates to work on my assignments and study.	how important it is to take small breaks every so often to avoid getting too stressed.
I leave all my homework to the very end and i am always rushing to get things done on time.	I could manage my time a lot better.	start working early on homework so that i have enough time to finish it.
I am not managing my time very well right now.	creating a calendar that includes all important assignment and test dates	completing assignments early is more effective since I can ask questions to professor or mentor.
making a schedule, using a calendar, and using course resources effectively.	start working early on assignments and focus because sometimes I do my homework with my study group, but we frequently talk so much	I need to get more organized and take more responsibility when it comes to do my homework.
i prepare a detailed schedule of what need to do for the week.	to do my homework in time and to not wait until the last day or minute.	take breaks every hour when i am studying for long periods.
I try to manage my time by doing the homework a couple of days before it is due and not wait until the last minute.	I should start studying for exams earlier since it covers a lot of material.	should make a list with everything I have to do and not procrastinate.
use the most of the time between lectures and when I am not at school to work on homework assignments and go over notes	make a schedule of time available when I am not at work or school so that I can allocate time specific for studying or working on assignments	it is important to make a to do list for the week and prioritize work by due dates and assignments which might give me the most problems
attending all classes on time and taking notes in class, I try my best to work on homework early and mark important dates in my phone calendar.	preparing a schedule of work hours and study hours.	Something I learned is to take short breaks when studying.

Table 6 presents some of the students' opinions about note taking during class and what they have learned from the guidelines to improve taking, organizing and using those lecture notes.

Table 6. Student comments about note taking in class

Note Taking during Class		
Make a positive comment of what you do about "Note taking during class", another comment about what you could do better, and indicate something you learned from the provided information about this topic.		
Something you are doing now	Something you can do better	Something that you learned
copy what the teacher has on the board, or the projector after he/she is done writing	compare my notes, and add to them with the information in the book	they should all be kept in binders along with exams and other assignments
getting home after class and organize whatever is unclear or hard to understand; re-do problems I did not quite get.	get to class early and go over the past class notes	take key notes and write down examples explained in class and the procedure used by the instructor to solve the problems
I take notes during class so I can look at them later when I am working	print out the power points and write the additional notes on the	read the textbook before class so I can be better prepared for the lecture
writing down examples explained in class, keeping all my notes in an organized way in a binder	compare the information provided in class to the textbook, since I do not usually read the book	the biggest problem I have is not to use the textbook
I listen first to the professor and what he is saying and then I write an observation or something important	reading the textbook before the class starts to improve my knowledge in the material covered.	it is always helpful to take notes during class, that way I will not have to remember everything by my own
my notes are problems and formulas where I can go back and see where numbers come from step by step.	focusing on writing what the professor is saying.	I should not rely on my memory "thinking" I will remember what the professor wrote down.
I keep dates and titles to stay organized and I write clearly so it is not messy.	rewrite the notes and add things that will help me better comprehend the material	maintain a organized binder and to read ahead before the lectures.
writing down everything that the professor writes down on the board, follow the thought process, and make any important side notes	organize my notes and worked-out homework problems better, instead of having them out of order.	focus more on the idea and context of what the professor is writing on the board, instead of just trying to write everything down.

Table 7. Student opinion about mentoring and office hours

Office Hours and Peer Mentoring		
Make a positive comment of what you do about the "Office Hours and Peer Mentoring", another comment about what you could do better, and indicate something you learned from the provided information about this topic.		
Something you are doing now	Something you can do better	Something that you learned
I am currently going to mentoring sessions.	I should go to more office hours for any unanswered questions I always stay with.	I learned the expectations the mentors as well as the professor have when I go to the sessions
I am left with questions I am afraid on talking to the professor one on one. As to peer mentoring I have been attending several of them and they have resulted to be very helpful.	reaching out to the professor and meeting with them can help one have a better understanding of whats going on in class.	Office hours is something I need to improve a lot
I am a quiet learner, I solve better what I don't understand by putting attention when others ask questions during the peer mentoring	I could participate with the conversation of the questions more because sometimes I believed I have better examples to express.	The more you expend time "with" others with the same issues as you and solve them, the more you going to understand that topic.
Something I do with the office hours is use them to ask questions regarding the homeworks.	go with the instructor more often and ask for help with the concepts in general, not just homeworks	peer mentoring is experienced students that help struggling students, not the instructors or a faculty member
I have gone to every single peer mentoring meeting and every time I have a hard question I go to my professor's office hours.	I should ask about the lecture notes as well, because I have only been asking why I messed up on the quizzes I have been given.	Attend mentoring when you need some assistance with course content or assignments.
I like to go and ask question to the mentors because they are very helpful and patient.	Something that I can do better is that I can go to the office hours and ask question to the professor.	attending mentoring will be important to understand, clarify and solve all the question we have.
I attend mentoring to better understand the material.	I should visit the professor during his office hours more often when I need some guidance.	I learned what not to expect during office hours and when going to the mentors.
I am attending mentoring sessions in which I complete homework assignments and prepare for exams	I can attend my professors office hours to ask him/her questions on material I don't completely understand.	it shows your professor that you are interested in mastering the material
When I have questions regarding a homework or a quiz question that I did not understand I seek help with the mentors in the Engineering lab.	I can start visiting the professor to let him know where my problem is that I do not understand from the mentors or notes.	it is very important to seek for help because if I don't, the only one that will get behind will be me.
i attend at least one mentoring every week. I find that the mentorship is very useful especially when i do not understand something in the lecture.	visit my professors office when i get the chance because obviously they are the best source of help i can ask for regarding their class.	i have not been taking the time to go to my prfessors office hours when i need help
I have only attended the mentoring. It has really helped me understand the material needed for the class.	I believe I should talk to more people in order to receive and give help when it is needed.	I learned that the professor and the peer mentors are there to help when needed.
When I struggle on a particular topic I make sure to consult the professor and/or a tutor.	I can be more consistent in going to my professors office hours.	I learned that attending tutoring sessions can give one experience to become a future mentor.
Something I am doing regarding peer mentoring is working with a partner while doing homework.	go to the mentoring sessions or to the Professor's office hours for more help.	I learned that it is vital to ask informed questions rather than ask a general or broad question.

From the students' opinions in Tables 3 through 7, it is estimated that lower-level STEM students require guidelines and expectations about best study practices to not only become successful STEM students but also to develop organizational, communication, time management, and adaptive expertise skills.

V. CONCLUSIONS

This study focuses on lower level engineering gatekeeper courses in order to provide students with guidelines, expectations, and information to promote successful learners with best study practice skills. After noticing that students in our courses struggle with organizational, time management, note taking, homework solving, office hours and peer mentoring, and syllabus skills, an online activity was implemented to provide them with information and to obtain their opinion about best study practices that might determine success in the courses.

From the students' opinions about best study practice guidelines and expectations, it is determined that lower level STEM students require activities to become informed and familiar with this information and to implement them in their courses. It is the intention of the authors to develop such skills in lower level STEM students in order for them to continue implementing them in subsequent courses throughout their career.

Future work in this project consists of completing the evaluation of results in Statics, Digital Circuits I, Computer Science I, Calculus I, and Chemistry I and adapting, developing, and implementing the materials required to perform the proposed interventions in the corresponding gatekeeper courses. This project is ongoing and it is in the middle of the third year of a total of five years.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support of the National Science Foundation Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) Graduate 10K+ program (grant number DUE-0311349) with special funding from Intel and General Electric, under which this project was carried out. We would also like to thank the UTPA Center for STEM Excellence (C-STEM) and its director, Dr. Cristina Villalobos, for assistance and support. Moreover, we thank the UTPA Center for Survey Research and Dr. William Donner for assisting with evaluation and data collection.

REFERENCES

- [1] Vasquez, H., Fuentes, A. A., Kypuros, J. A., & Azarbayejani, M. (2015, October). Early identification of at-risk students in a lower-level engineering gatekeeper course. *Frontiers in Education Conference (FIE)*, 2015. 32614 2015. IEEE (pp. 1-9).
- [2] Griff, E. R., & Matter, S. F. (2008). Early identification of at-risk students using a personal response system. *British Journal of Educational Technology*, 39(6), 1124-1130.
- [3] Efimba R.E, Smith T., (2012), Prerequisite Courses and Retentivity as a Challenge", Proceedings of the 2012 ASEE Annual Conference and Exposition.
- [4] Huang, S. (2011). Predictive modeling and analysis of student academic performance in an engineering dynamics course.
- [5] Steif, P. and Dollar, A., (2012), "Relating Usage of Web-Based Learning Materials to Learning Progress", ASEE Annual Conference, AC 2012-3478.
- [6] Van Arsdale, T. and Stahovich, T., (2012), "Does Neatness Count? What the Organization of Student Work Says about Understanding", ASEE Annual Conference, AC 2012-4663.
- [7] Rawson, K., and Stahovich, T., (2013), "Predicting Course Performance from Homework Habits", 120th ASEE Annual Conference.
- [8] Besterfield-Sacre, M., Atman, C. J., & Shuman, L. J. (1998). Engineering student attitudes assessment. *Journal of Engineering Education*, 87(2), 133-141.
- [9] Besterfield-Sacre, M., L. Shuman, H. Wolfe, A. Scalise, S. Larpiattaworn, O. S. Muogboh, D. Budny, R. Miller, and B. Olds. 2002. "Modeling for educational enhancement and assessment." In *American Society for Engineering Education Annual Conference*.
- [10] Besterfield-Sacre, M., Larry Shuman, L., Yildirim, T. 2010. Scale Development For Engineering Modeling Self Efficacy, ASEE Annual Conference & Exposition
- [11] Bandura, A. (2006). Guide for constructing self-efficacy scales. *Self-efficacy beliefs of adolescents*, 5(307-337).
- [12] Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- [13] Denzine, Gypsy, 2007, Five Misconceptions about Engineering Students' Motivation that Affect the Teaching and Learning Process, ASEE Annual Conference & Exposition
- [14] Scalise, A., Besterfield-Sacre, M., Shuman, L., & Wolfe, H. (2000). First term probation: Models for identifying high risk students. In *Frontiers in Education Conference*, 2000. Vol. 1, pp. F1F-11.
- [15] Webster, T. J. & Dee, K. C. (1998). Supplemental Instruction Integrated Into an Introductory Engineering.
- [16] Dukhan, N. and Schumack, M., 2013, Understanding the Continued Poor Performance in Thermodynamics as a First Step toward an Instructional Strategy. ASEE Annual Conference.
- [17] Blat, C., Myers, S., Nunnally, K., & Tolley, P. (2001, June). Successfully applying the supplemental instruction model to sophomore-level engineering courses. In *American Society of Engineering Education National Conference Proceedings*.
- [18] Knight, D. W., Carlson, L. E., & Sullivan, J. (2007, June). Improving engineering student retention through hands-on, team based, first-year design projects. In *Proceedings of the International Conference on Research in Engineering Education*.
- [19] Thompson, B. R., & Geren, P. R. (2002). Classroom strategies for identifying and helping college students at risk for academic failure. *College Student Journal*, 36(3), 399-403.
- [20] <http://www.colorado.edu/gtp/2013/01/29/professors-students-and-syllabus>. Professors, Students, and the Syllabus. Graduate Teacher Program; The University of Boulder.
- [21] Parkes, J. and Harris, M. (2002). The Purposes of a Syllabus; *College Teaching*, 50, No. 2.
- [22] <http://www.eng.vt.edu/mentoring/whatismentoring>. What is Mentoring? Virginia Tech.
- [23] <http://simpsonu.edu/Pages/About/Resources/Student/Academic-Success/Tutoring.htm>. Tutoring Information. Simpson University.
- [24] <http://tutoring.engineering.asu.edu/> FSE Tutoring Centers, Fulton Schools of Engineering, Arizona State University.
- [25] <http://www.aston.ac.uk/current-students/get-involved/mentoring-at-aston-university/peer-mentoring/> Benefits of Peer Mentoring. Aston University.
- [26] <http://mentoring.eng.ua.edu/undergraduates/peer-mentee-roles-and-responsibilities/> Peer Mentee Roles and Responsibilities. College of Engineering. University of Alabama.
- [27] Taylor, Annie. <http://classroom.synonym.com/advantages-disadvantages-study-group-4192.html> What Are the Advantages and Disadvantages of a Study Group?