

WHY STUDENTS LEAVE STEM?

Dr. Youngjin Song / Science Education

Dr. Ann Kim / Human Development

Dr. Lisa Martin-Hansen / Science Education

Dr. Elaine Bernal / Chemistry





WHY STUDENTS LEAVE STEM? — COURSE

■ Faculty pedagogy

- “poor teaching by S.M.E. faculty” was the third most frequently-mentioned reason for SME switching decision (Seymour & Hewitt ,1997)
- the quality of STEM faculty teaching and accessibility was the main factor that was significantly related to students’ intention to switch or drop out STEM majors (Xu, 2018)

■ Introductory classes

- negative experiences in introductory math and science courses, often called “gatekeeper” or “gateway” courses , which in turn, discourage students from pursuing a STEM major continuously (Crisp, Nora, and Taggart 2009; Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012; Mervis 2010; Seymour & Hewitt 1997)

■ Academic performance

- student achievement in gateway science courses (e.g., introductory biology) in college is of utmost importance in STEM students’ academic motivation and retention in majors (Dai & Cromley, 2014)
- students in physical and life science tend to leave their majors when they receive high grades in non-science courses and low grades in their major courses (Ost, 2010)





WHY STUDENTS LEAVE STEM? — CONTEXT

- **Academic support programs (e.g., advising/counseling)**
 - 75% of SME switchers mentioned inadequate advice, counseling or tutorial help as a factor for SME switching decision (Seymour & Hewitt ,1997)
 - attempts improve academic support programs for STEM majors (Wilson et al, 2012; Graham et al, 2017)
- **Support from faculty and peers**
 - students are more likely to persist when their peers are more likely to persist (Ost, 2010)
 - receiving support from STEM peers or classmates is significant for the retention of female STEM students (Hilts, Part, and Bernacki, 2017; Maltese & Cooper, 2017)
- **Structural features (e.g., class size)**





WHY STUDENTS LEAVE STEM? — INDIVIDUAL

- **Gender**

- women are more likely switch out of STEM field than men (Astorne-Figari & Speer, 2018; Crisp, Nora, & Taggart 2009; Green & Sanderson, 2018; Maltese & Cooper, 2017)

- **Ethnicity**

- students' ethnicity has no significant impacts on their intention to drop out or change STEM majors (Shedlosky-Shoemaker & Fautch, 2015; Thompson & Bolin, 2011; Xu, 2018)

- **Family backgrounds**

- STEM entrants' parental education, income levels, and demographic characteristics were not significantly associated with the outcome of leaving STEM fields by switching majors (Chen, 2013)

- **Pre-college experiences/abilities**

- AP credits in high schools influenced on students' STEM course taking (Rask, 2010)
- higher SAT scores enhance persistence and graduation rates in STEM fields (Green & Sanderson, 2018)





WHY STUDENTS LEAVE STEM?

- Multiple factors influence simultaneously affecting students' decisions to move out of STEM fields
- What are the meanings of these factors that STEM entrants encounter?
- How do they influence students' STEM major switch decision?
- Psychological factors: STEM identity (read the paper)



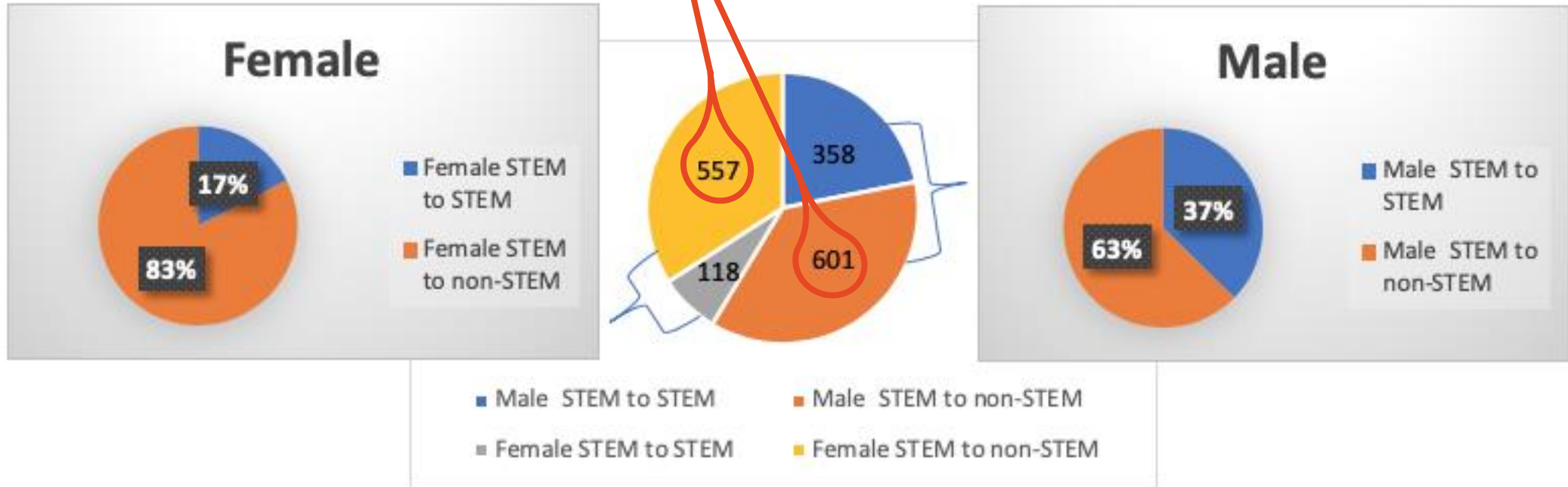


2013-2017 COHORT: HOW MANY

5351
STEM
Majors

1158 (71%) to non-STEM

1634 (31%)
Leave





2013-2017 COHORT: WHEN?

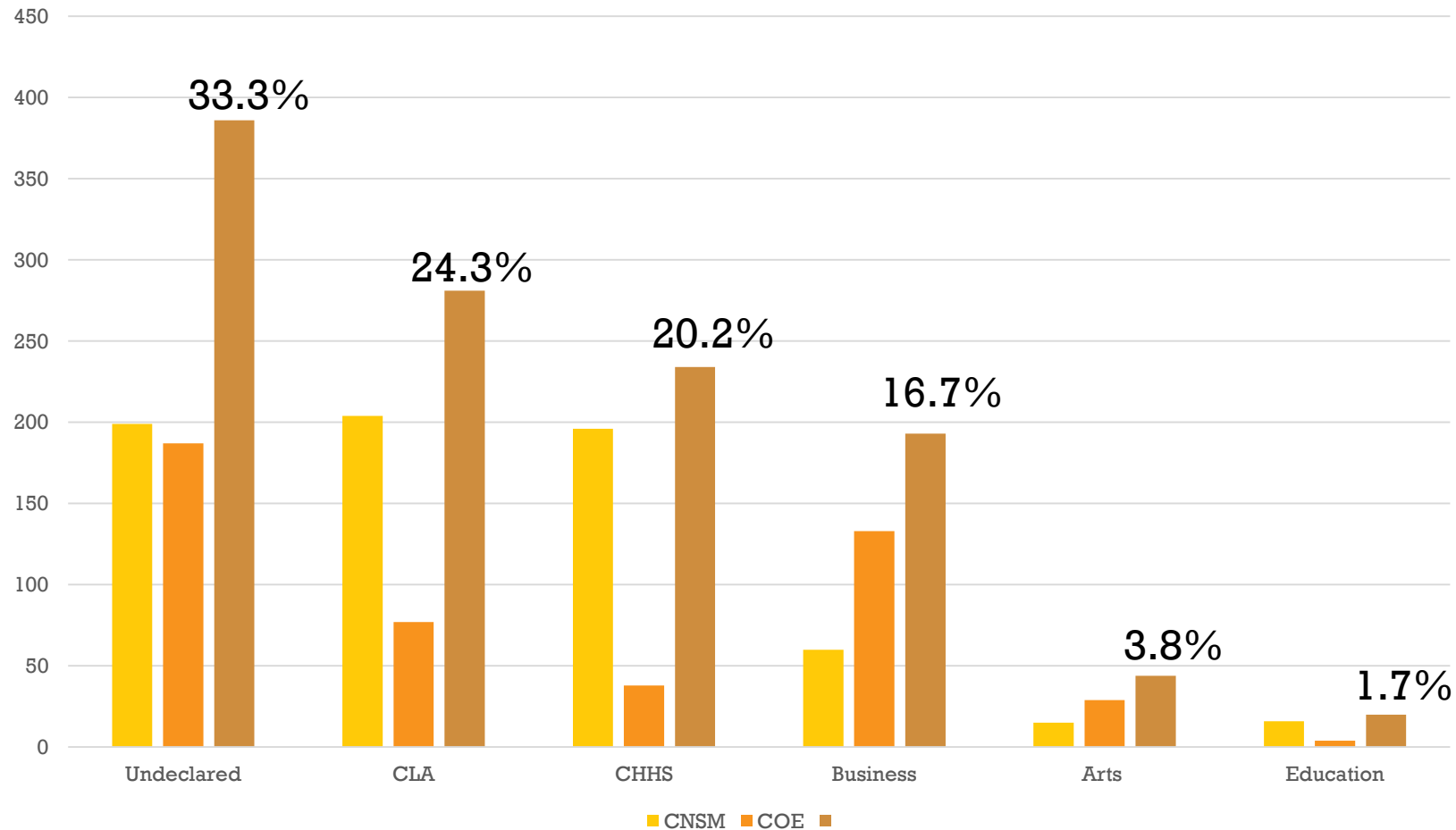
Semester Cohort Year	2	3	4	5	6	7	8	9
2013	197	1	82	74	40	30	15	16
2014	148	4	95	86	39	22	11	14
2015	158	1	75	60	29	23	0	0
2016	133	14	69	62	0	0	0	0
2017	124	5	0	0	0	0	0	0
Total	760	25	321	281	108	75	26	30





2013-2017 COHORT: WHERE?

Destinations of Switchers



Name	Gender	Ethnicity	Starting Year	Initial Major	Switching Year	Final (or Current) Major
STEM to STEM switchers (8)						
Kelsey	Female	White	2015 Fall	Physics	2017 Fall	Math/Physics
Kirsty	Female	White	2017 Fall	Marine Biology	2018 Spring	Math Education
Danae	Female	Asian	2015 Fall	Marine Biology	2018 Spring	Environ Science
Lily	Female	Asian	2017 Fall	Biology	2018 Fall	Biochemistry
Chloe	Female	Latina/Hispanic	2016 Fall	Biochemistry	2017 Spring	Microbiology
Gaby	Female	Latina/Indian	2015 Fall	Mechanical Engineering	2018 Summer	Physics
Daniel	Male	White	2013 Fall	Physics	2015 Fall 2017 Fall	Chemical Engineering Biochemistry
Joshua	Male	Asian/Pacific Islander	2013 Fall	Biomedical Engineering	2015 Spring	Biochemistry
STEM to STEM-adjacent switchers (6)						
Addie	Female	White	2016 Fall	Biology	2017 Spring	Industrial Design
Jacee	Female	Southeast Asian	2015 Fall	Pre-Chemistry	2017 Fall	Health Science
Alicia	Female	Asian	2015 Fall	Comp Science	2017 Spring	Information Systems
Sarah	Female	Latina/Hispanic	2013 Fall	Biology	2014 Spring	Health Science
Jeremy	Male	Asian	2015 Fall	Computer Engineering	2017 Spring	Information Science
Calvin	Male	Half Asian	2013 Fall	Mechanical Engineering	2014 Spring	Industrial Design
STEM to non-STEM switchers (9)						
Mary	Female	White	2014 Fall	Biology	2015 Spring	Psychology
Hannah	Female	Asian	2016 Fall	Chemistry	2018 Spring	Recreation
Sofia	Female	Asian	2015 Fall	Biology	2017 Fall	Psychology
Angela	Female	Pacific Islander	2015 Fall	Biology	2017 Spring	Psychology
Tonya	Female	Latina	2017 Fall	Aerospace Engineering	2018 Fall	Film
Jared	Male	White	2014 Fall	Mech Engineering	2015 Fall	Economics
Chris	Male	Asian/European	2013 Fall	Organismal Biology	2015 Spring	Psychology
Carl	Male	Asian/Pacific Islander	2013 Fall	Biology	2014 Fall	Communication
Marco	Male	Latina	2016 Fall	Pre-Mech Engineering	2018 Spring	Consumer Affairs

WHAT WE HEARD . . .



STRUCTURE OF COURSES

- Our students pointed out how introductory courses being taught didactically in large lecture halls full of students was challenging, consistent with current research on undergraduate STEM courses (Stains et al, 2018).





CHALLENGES: LARGE CLASS & LACK OF INTERACTION

- “The 100 Engineering class was a lecture course with 100 people and **you’re just kind of in the back**.... I don’t think they were rude or anything like it, just like ... ‘huh’, you’re going through it, you know **you’re one in 100**’, ‘okay, I go to class, I do the work.’” (Calvin, SN, male, Half Asian)
- “I understand because it’s like a big lecture hall, and it is hard to really help students **one-on-one**.” (Jacee, SS-adj, Female, Asian)
- “I think that the biggest challenge for me was seeing all of my peers knowing what they were doing and me just **feeling lost**. And that’s what really pushed me out.... It was so frustrating” (SN, Female, Pacific Islander).
- “I feel in general that the [STEM] field can be **lonely** because people are just studying all the time, and there isn’t [initially an] **expectation for you to study with other people**.” (Carl, SN, Male, Asian/Pacific Islander).





CHALLENGES: PERCEPTION OF INSTRUCTION

- “Physics labs were totally nonsense. It seemed like most of the time, the physics lab **instructor was just as lost as we were**, and everyone just wanted to fill out the worksheets and get out of there including the instructor. So, I didn’t really feel like it was constructive.” (Daniel, SS, Male, White)
- “Yeah... those problems. I understood how to do it. Just like step one, step two. But then I think overall, I just, **I didn't get the conceptual part.**” (Jacee, SS, female, Asian)
- “**They just expected you already know the things.** They kind of assume that when you ask them questions, you’re doing it because you’re lazy because you’re not trying to figure it out first.” (Chris, SN, Male, Asian/European)
- “the pace at which I was taught was **very, very fast** for me” (Lily, SS, Female, Asian)





CHALLENGES: PERCEPTION OF INSTRUCTORS

- “[They] have office hours but they’re like, ‘Well, **it’s in your notes**. It’s right here. This is what it means.’ I am telling them like, ‘This is my knowledge of it. Can you help me understand what parts I’m not getting from?’ ... I understand a portion of how it works, and they will be like, ‘You’re not seeing the bigger picture,’ and I’m like, ‘That’s why I’m here, that’s why I’m at your office hours,’ and I would explain what I know about it. And I feel like **they didn’t even hear me**. ... so it’s not really as encouraging and I feel like I’m being put down.” (Sofia, SN, Female, Asian)
- “The very first day of class, he was telling us, ‘Oh, **we’re gonna weed out the people that shouldn’t even be in here**.’ ‘Half of you will change your major’.” (Angela, SN, Female, Pacific Islander)






OPPORTUNITIES: PERCEPTION OF INSTRUCTORS

- “I had a professor in Chem 111A ... and really liked the way she taught.... I took Bio 208, which was Anatomy, and that **professor made it exciting**. ... I felt they were **good** in what they were teaching.” (Joshua, SS, Male, Asian/Pacific Islander)
- “I took [chemistry] over the summer, the classes were really small, so it did feel more intimate and the **professors were very, very understanding**. And it was like ‘we know that this class is very difficult.... If you are struggling, we are totally free to help you out.’ And it really showed in their efforts, and so it was **a good learning environment, very supportive**.... there wasn’t a single moment in that class where I thought it was easy, it challenged me a lot. But I didn’t feel overwhelmed even though the pacing was very fast.” (Lily, SS, Female, Asian)





CHALLENGES: PARENTAL PRESSURE

- "I didn't really choose to be quite honest, **my mom wanted me to be a doctor**, so most logical answer to I wanted to be a doctor as well, and so, it made more sense for me to, in order to reach all the medical school requirements, just do Bio because that was obviously what you would get your degree and get all of the requirements done" (Angela, SN, Female, Pacific Islander)
- "It [first choice of Computer Engineering] was influenced by my mom because she's a chemical engineer.... Anyways, growing up, **she kept pushing me to study engineering**, 'This is good for you, I can see you doing this.' So it always stuck in my mind that I should pursue engineering. Yeah, so that's how I ended up with computer engineering." (Jeremy, SS-adj, Male, Asian)
- "I'm like the English gal, I'm the humanities person, and so, when I went to my parents, they basically told me, **we are not gonna pay you for college** [laugh] if you are gonna major in English, and like **I'm okay I will just do sciences because I know at least that's something that they're more comfortable with**, and so, I went in knowing that I'm decent at science but **it's not something I would generally consider**" (Lily, SS, Female, 



CHALLENGES: PERCEPTION OF ADVISEMENT

- “I went to the advisor in STEM once, and I didn’t have a really good experience. I was asking whether I should add this, it was a biostatistics class, to my schedule... she told me, ‘Oh, it’s up to you’ I needed support and like, ‘what have you seen other students do?’ She was like, ‘Well, it’s up to you, do you think you can handle it?’ I didn’t feel she helped me very much.” (Angela, SN, Female, Pacific Islander)
- “In my program within President’s Scholars, we had to do semester advising. They didn’t exactly prepare me into finding what I wanted to do. It was more like just a check in. So, I would say a lot of it was on me.... I can’t necessarily say that I had a resource to look at.” (Joshua, SS, Male, Asian/Pacific Islander)





OPPORTUNITIES: PERCEPTION OF ADVISEMENT

- “So, I did meet with some of the advisors over at the **Student Success Center**, and so I did a lot of meetings with them. I tried to plan out, trying to figure out what I wanted to do. We landed upon consumer affairs.” (Marco, SN, Male, Latina)
- “Yeah, they had some **mandatory advising** for us. **That helped definitely, especially since we were first year starting...** I did go for advising a couple other times to talk about classes but that’s about it.” (Jeremy, SS-adj, Male, Asian)



OPPORTUNITIES: REASSESSING AND EXPLORING

- “Yeah, taking the lab classes, The lab classes are my favorite portions of any class. They are just fun but I decided, ‘Oh, I want to do more with the environment instead of specific animals or people...I’m doing [Biology] 212 class right now and we are doing plants in our section, and I’m like, ‘Oh, this is fun. Why can’t I do more of this?’ You know.”
- And, I feel like once I took my first Gen Chem class, which is what biochemistry and biomedical engineering students had to take, I feel like that was a big factor in what made me switch because out of all my classes especially science to that point, I really really liked Gen Chem. So, that was a big component of me saying like, ‘Okay, I don’t want to be an engineer anymore. I want to do something in chemistry.’



CONCLUSIONS -- INSTRUCTION

- Students are not struggling in all STEM lecture courses.
- There is an indication that we are making some headway into creating interactive, application-based courses where students have peer interactions and can see direct ties to their lives and to their careers. Innovations are reaching some students. However we still have improvements we can make.



CONCLUSION -- INSTRUCTORS

- Research has found that simply repeating what we said *more loudly and slowly does not help* student learning, research concurs that that is often a first reaction from an instructor.
- Instead -- **error analysis** can be used.
- **Peers** are sometimes better in re-interpreting and explaining information in different ways. Asking students to interact with another brain or two DURING lecture (there are many strategies for doing this in large lecture courses), can make a difference in student understanding. This can also help with making the much needed CONNECTIONS to peers



CONCLUSION – COMMUNITY IS KEY

- Finding ways to create spaces where students periodically think together and talk together helps students make sense of the content.
- Additionally, this provides a means for students to meet each other, and depending on the task – study and work together.
- Findings like-minded peers can help students through rough patches.

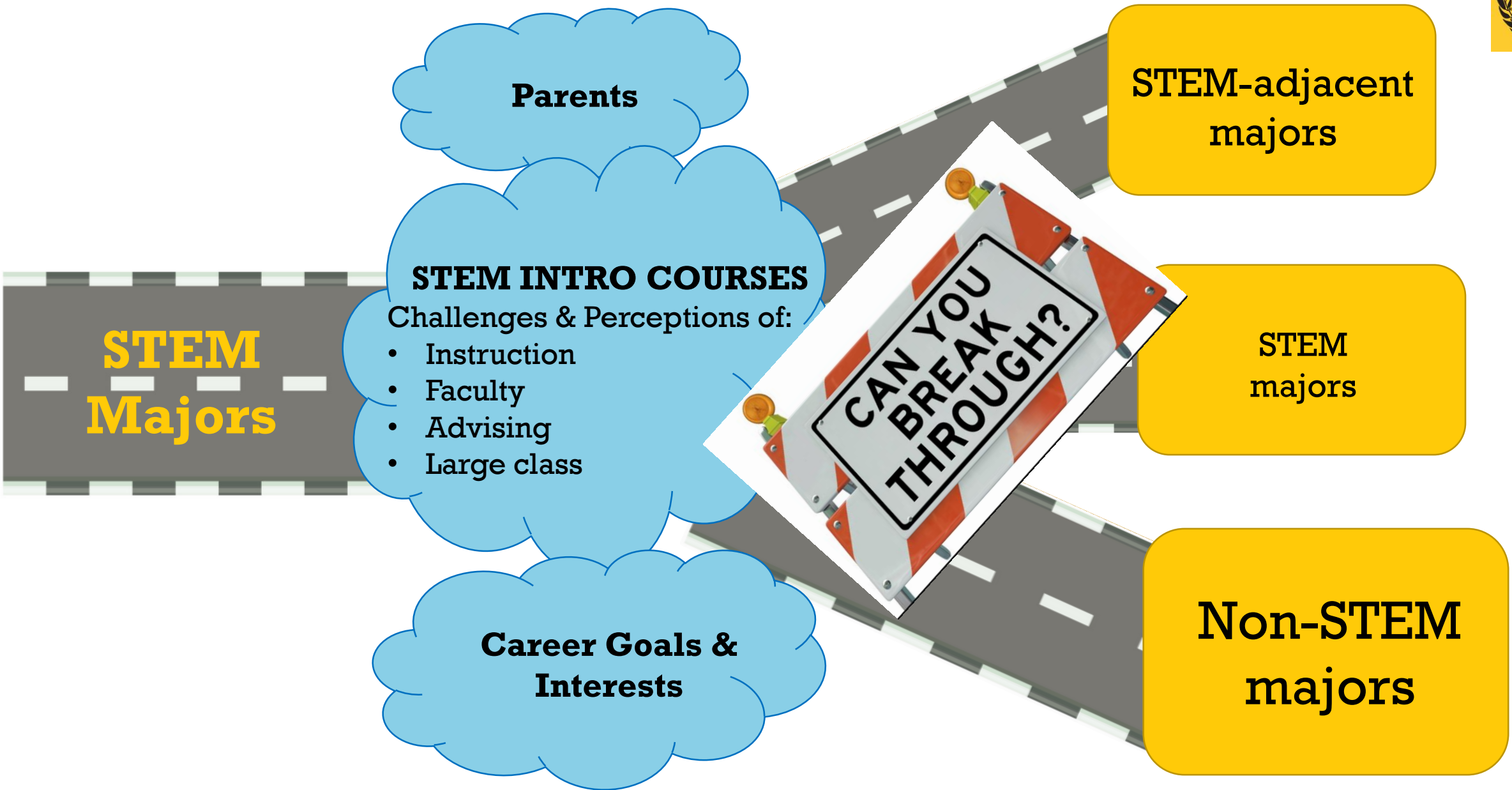
*“I was doing well in math, but Physics and Chem were SO difficult. But I just needed that foundation and those people and **those friends who actually pushed me through it,**” (Danae, SS, Female, Asian).*



ADVISEMENT

- Many students do not have clear career plans and those plans can change over time.
- Advisement has been extremely helpful in some cases and in other cases, students were confused or they were not sure what questions to ask to get the help needed.
- Finding more ways to provide career information would be very helpful to students who simply don't know about career characteristics and options. Job talks can be an option.







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<https://tinyurl.com/yyyrmgs2>