

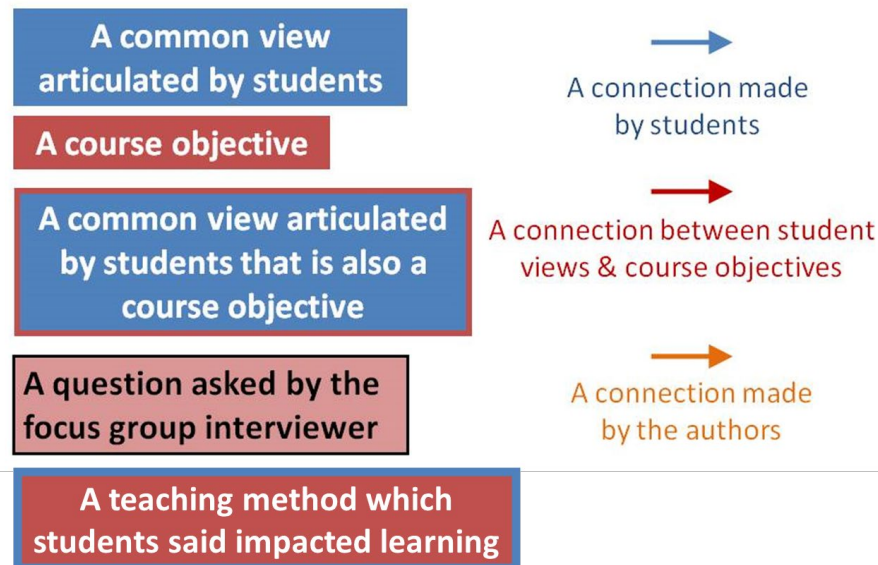
# Problem-Based Learning (PBL) and Traditional Instructional Models in College General Education Biology: Student Perceptions about Learning Science

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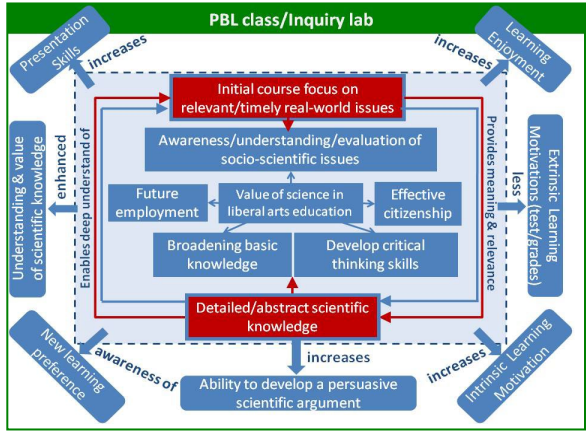
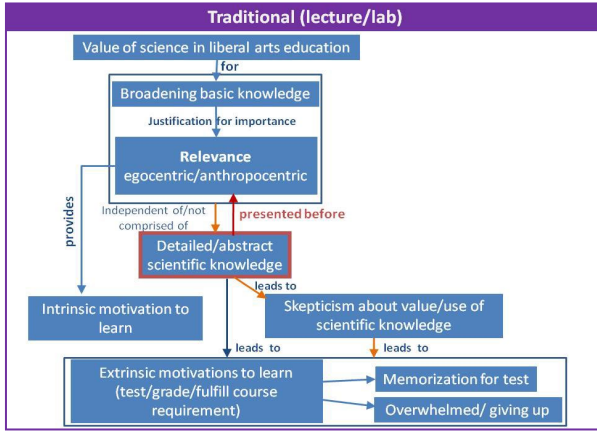
What follows is an interactive summary of import themes that emerged from pre- and post-reform focus group interviews of students taking BIOL 101/101L & 102/102L. Pre-reform focus group students were enrolled in courses that use traditional didactic modes of instruction in class, and verification-style lab investigation in the laboratory component of the class. Post reform students were enrolled in classes that used problem or case-based learning and used more collaborative learning pedagogies. The labs utilized and inquiry-based learning framework. Each map summarizes the project researchers' synthesis of student perceptions about learning that emerged from their course experience.

## Key to Focus Group Maps

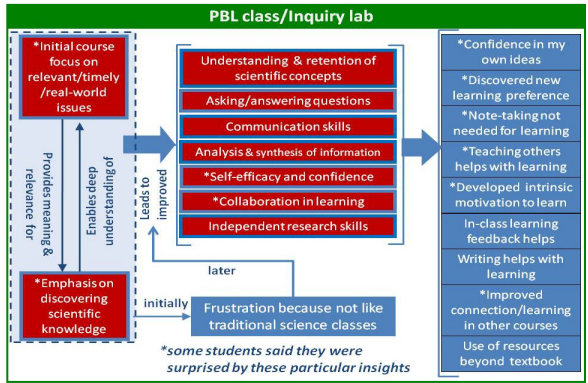
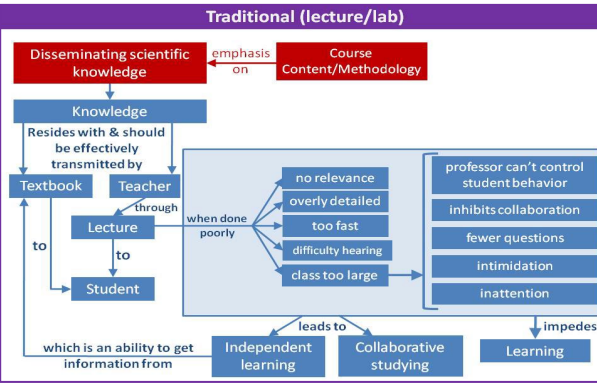


# Click on a map to view direct interview data in support of a theme or path in the diagram

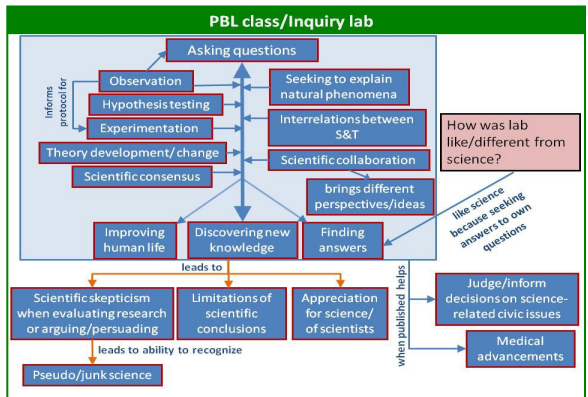
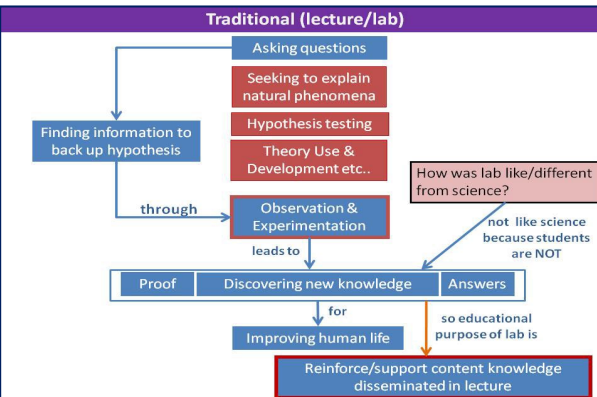
## Value of science in education & future lives



## Independent and self-directed learning



## Nature of science



Value of science in liberal arts education

for

Broadening basic knowledge

Justification for importance

Relevance

egocentric/anthropocentric

- How has this biology course contributed to your liberal arts education?
- What topics in this course seemed most/least meaningful to everyday life now and in the future?

Click on any box or path where the mouse arrow turns to a hand.

Independent of/not comprised of

presented before

Detailed/abstract scientific knowledge

provides

Intrinsic motivation to learn

leads to

Skepticism about value/use of scientific knowledge

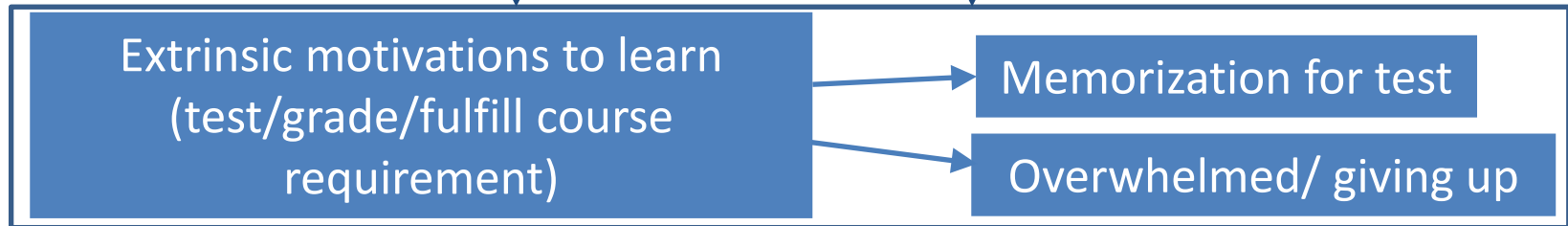
leads to

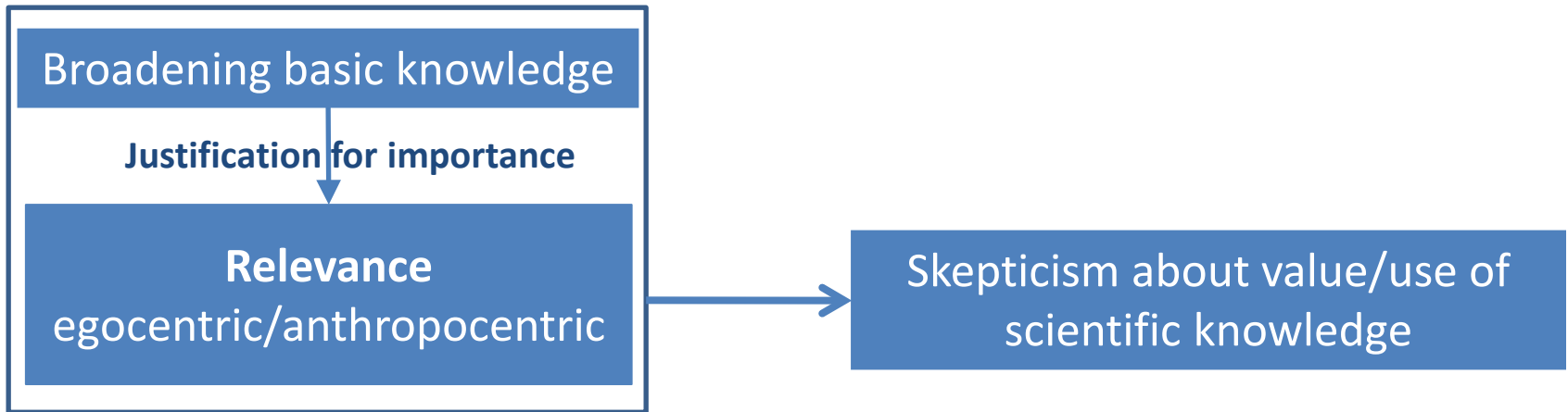
leads to

Extrinsic motivations to learn (test/grade/fulfill course requirement)

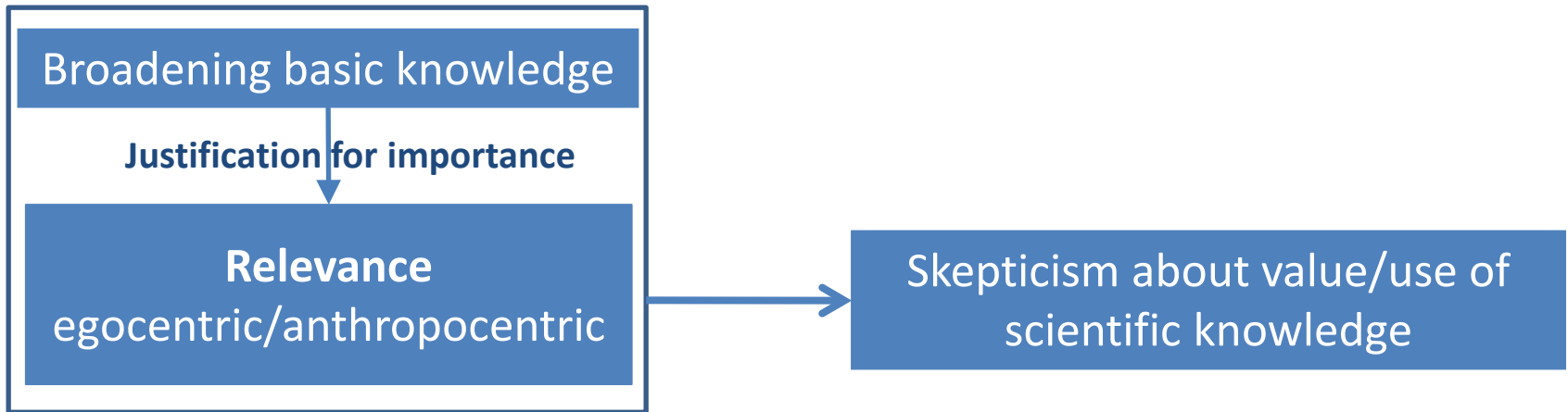
Memorization for test

Overwhelmed/ giving up



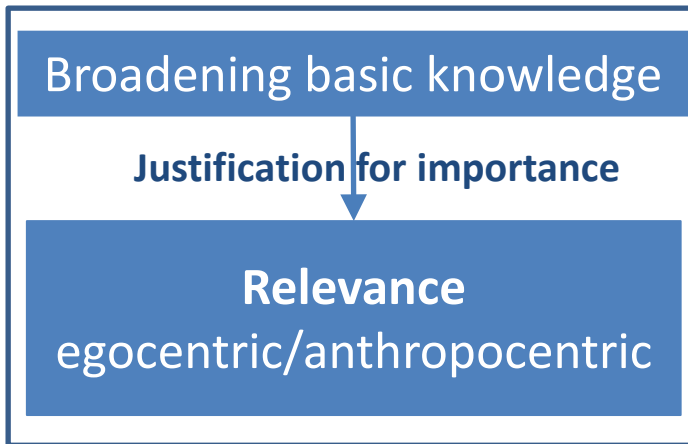


**Savannah:** “It could be useful when I run into a biology major and I’m able to have an intelligent conversation with them and I need to do a business deal and I need to open up lines of communication...”

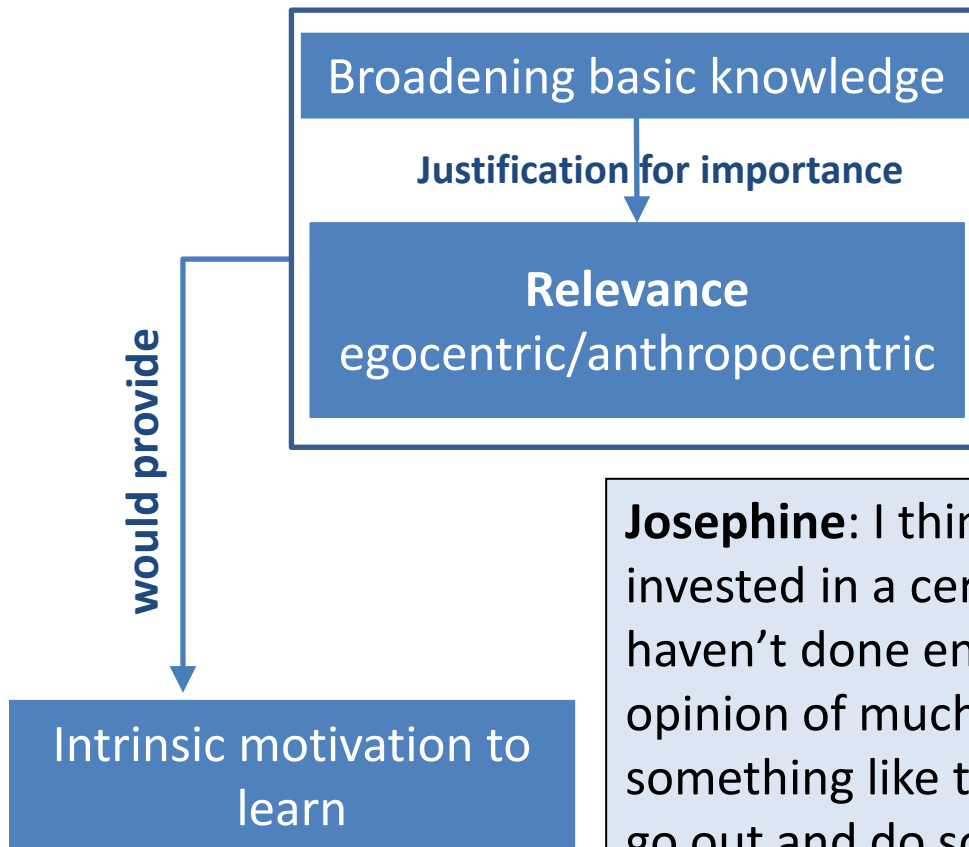


**Savannah:** “It could be useful when I run into a biology major and I’m able to have an intelligent conversation with them and I need to do a business deal and I need to open up lines of communication...

...It could be useful in that form or, but I don’t really ever see myself needing to know a lot of the information (laugh). But I mean it could be useful...”



**Kristi:** I think I need to understand that before I try to teach it to elementary school kids. Some things are really fascinating, like the genetics...there's a lot of different disorders and things that I have to cope with being inside of a classroom whether it be attention disorders...just different things I think in general will help me teach the kids better, since I have a better understanding...my teacher has done really well with taking little baby steps with us. So it's broken it down for me so I can do little baby steps like that in my class.



**Josephine:** I think that if you have a personal interest invested in a certain topic...Like stem cell research. I haven't done enough research to form a concrete opinion of much educational value and I think that if something like that was assigned and I actually had to go out and do something on my own and I found that I felt really strongly one way or the other that would be something that I would definitely look into on my own. Because I'm not against biology. I really do like some of the concepts but I feel like the things that I can relate to my own life and that I can kind of help to form my own opinions about things in the world that would help to have a more interest in the class.

Detailed/abstract  
scientific knowledge

leads to

Extrinsic motivations to learn  
(test/grade/fulfill course  
requirement)

Memorization for test

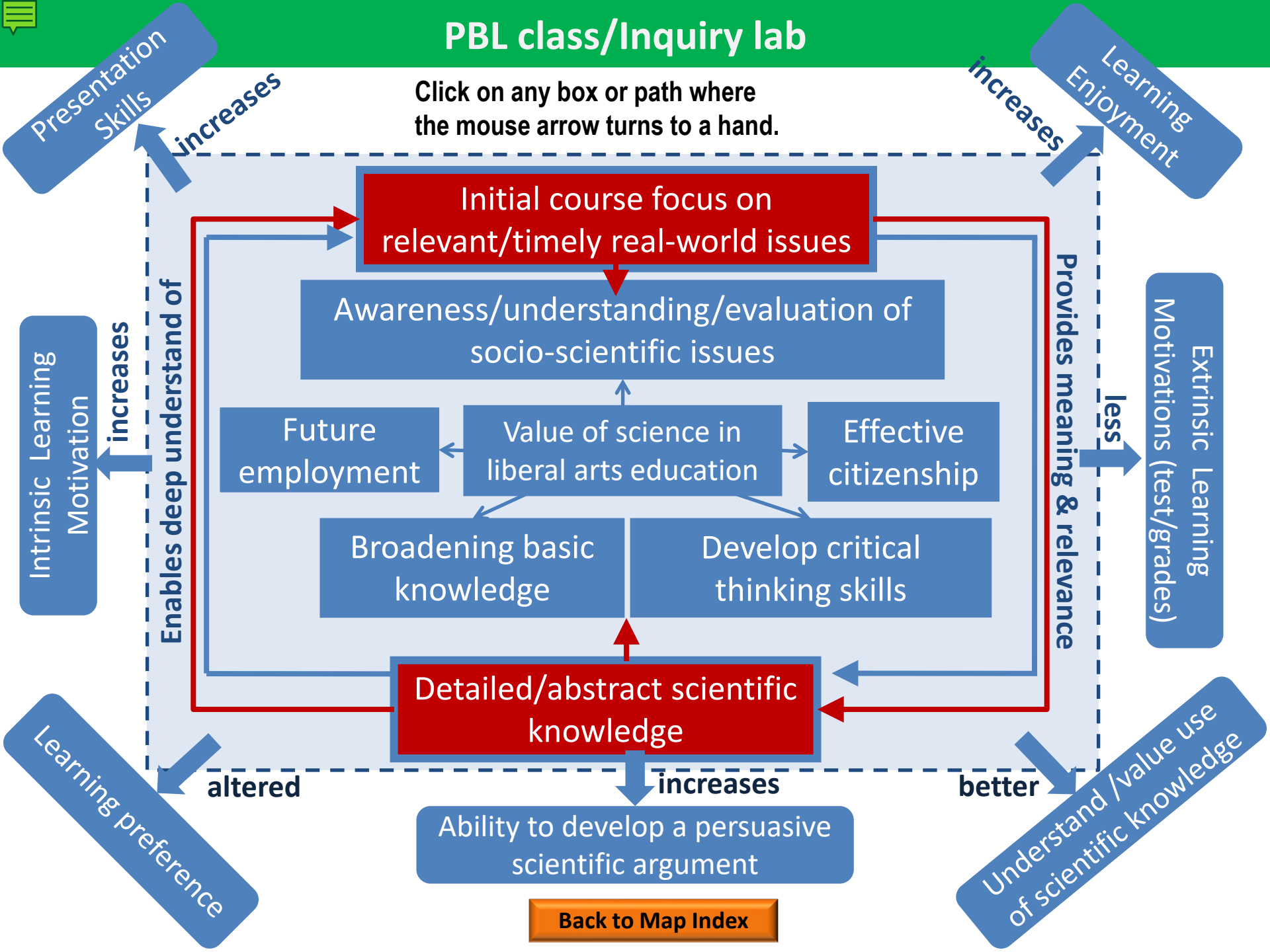
Overwhelmed/ giving up

**Randy:** In response to why instructors go into detail - I like science a lot [but]...things did not flow together in some type of progression, everything was disjointed and the detail is absolutely unnecessary...The problem...is that there's a lot of information which interests me but at the same time I'm not getting the information in a in a format where I can take notes in a class...I think the detail is necessary [*for biology majors*] but the problem is there's so much detail and there's so much information...You study for a test and then the information goes out the window unless you revisit it somehow...probably over the summer I will forget all about this (laugh)..."



# PBL class/Inquiry lab

Click on any box or path where the mouse arrow turns to a hand.



Presentation Skills

increases

increases

Learning Enjoyment

Initial course focus on relevant/timely real-world issues

Awareness/understanding/evaluation of socio-scientific issues

Future employment

Value of science in liberal arts education

Effective citizenship

Broadening basic knowledge

Develop critical thinking skills

Detailed/abstract scientific knowledge

Intrinsic Learning Motivation

increases

Provides meaning & relevance

less

Extrinsic Learning Motivations (test/grades)

Learning preference

altered

increases

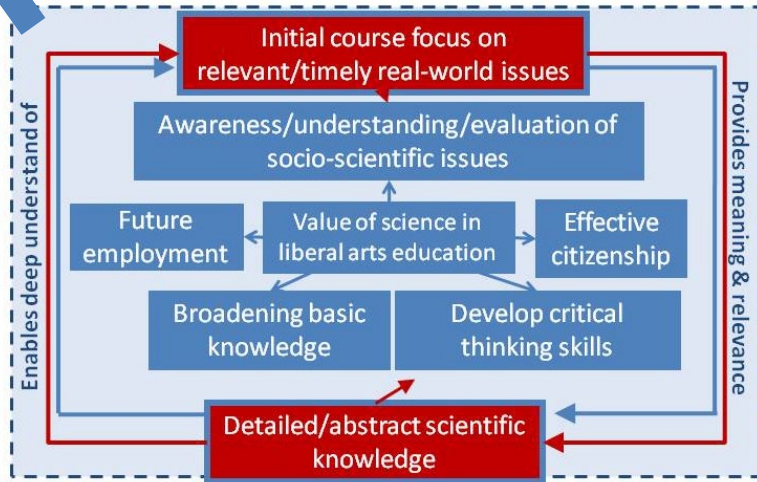
better

Ability to develop a persuasive scientific argument

Understand /value use of scientific knowledge

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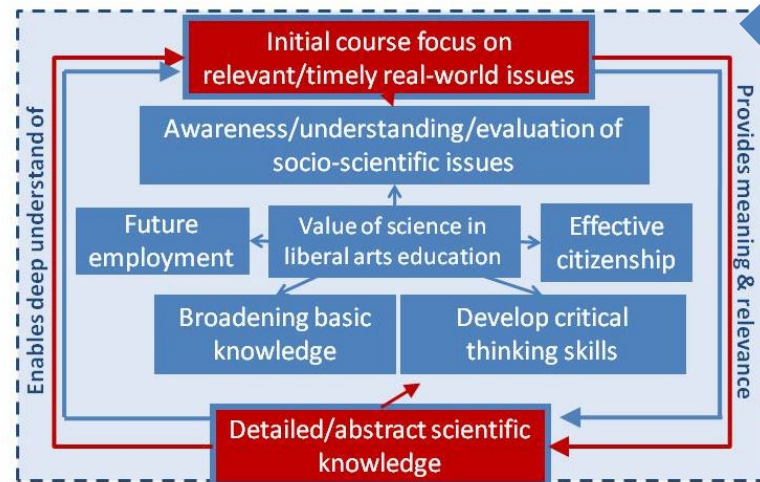
Presentation Skills  
increases



**Dori:** [In reference to a problem addressed in class] I also brought it to my public speaking class because of what I learned. I did a whole speech on it; and, I got an entire class to kind of go with what I was thinking. So that's kind of cool.

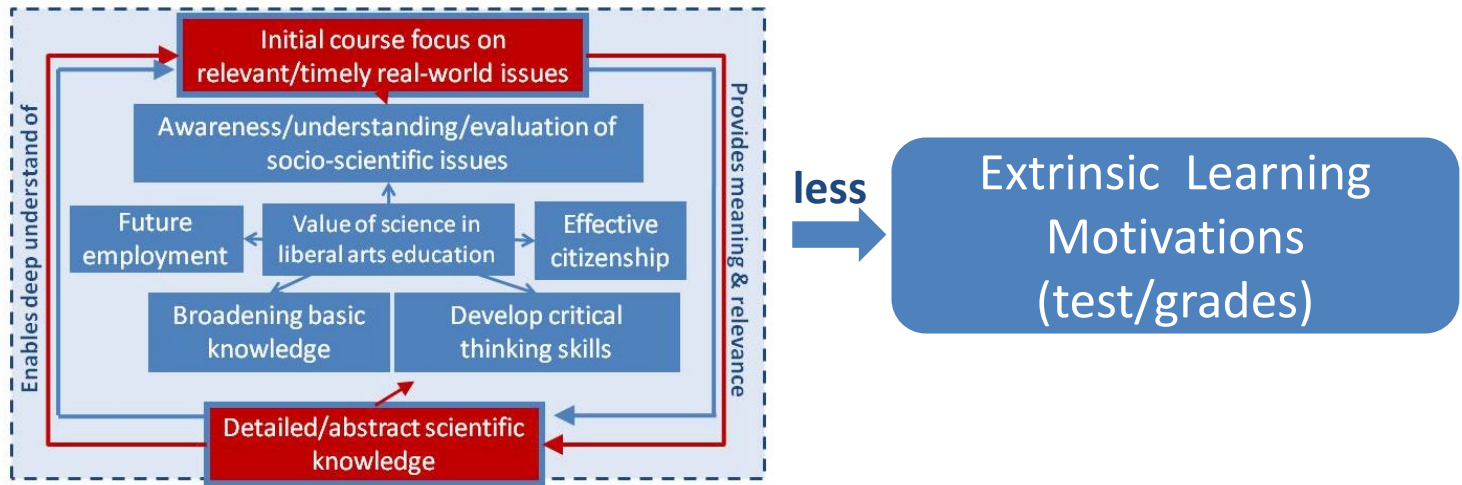
**Amber** - I also enjoyed intelligent design vs. evolution ...I started reading about intelligent design and they don't believe that evolution happened ... and I just realize how blind sometimes we can be ...[the case] really opened my eyes to how blindly people walk into things...these people aren't scientists they are just using the facts of evolution against evolution like oh, there's a gap in the fossil record or this that ... That was a big one for me because it was like something enjoyable for me to learn about. I really, and that is what really hit me, this is enjoyable for me to learn...

increases  
Learning  
Enjoyment



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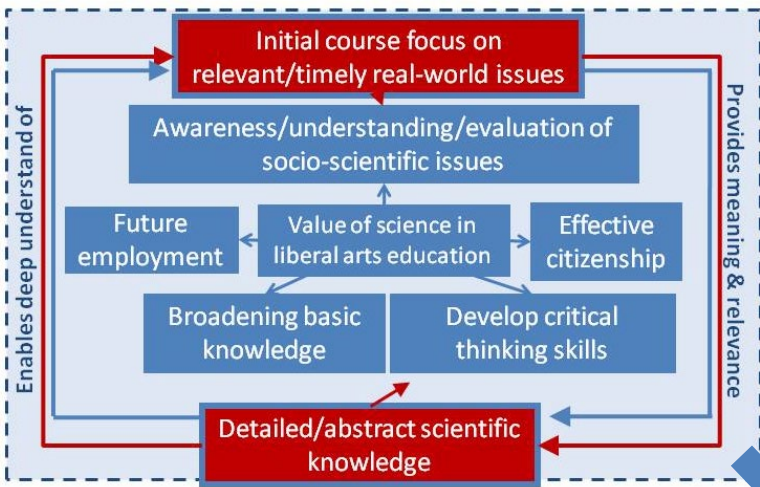


## Traditional

7 of 16 students (3 FG interviews) utilized test, grades, required assignments, or curricular requirements as providing a significant motivation for learning.

## PBL

None of the students from PBL classes (3 focus group interviews, 24 students), utilized tests, grades, required assignments, or curricular requirements as providing a significant motivation for learning.

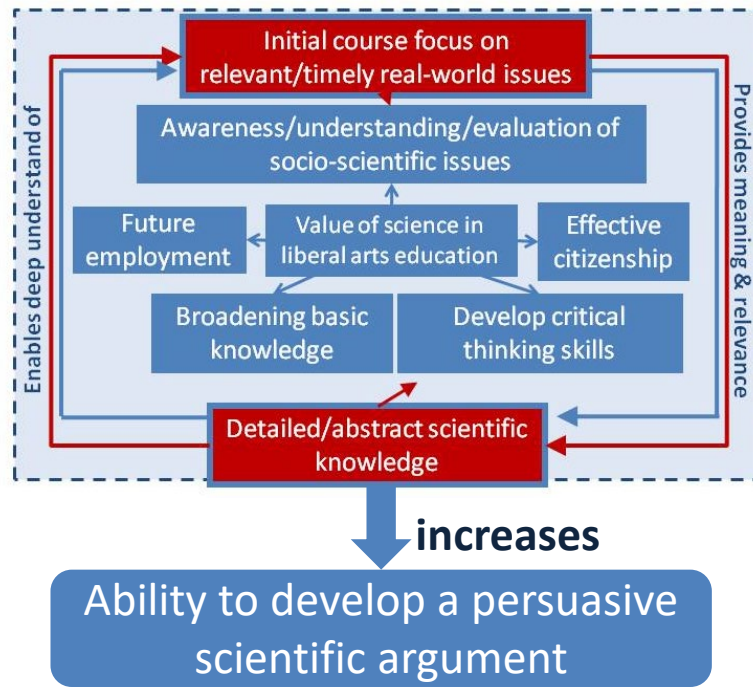


better

Understand /value use of scientific knowledge

**Allison:** It helps us be better citizens...we talked a lot about the current issues that are going on. It gives us background in understanding.

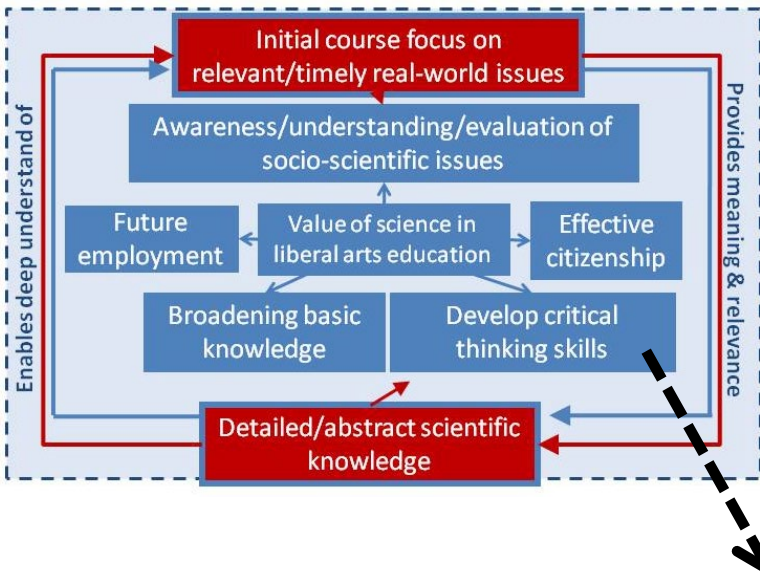
**Katie:** I think our case study on the long-leaf pine was really relevant to today because that's what's going on right now with the Francis Marion National Park. So it was cool to learn about it and it was really interesting. We need to be aware and it was good for us to know.



**Emily:**...civic issues [*were*] really interesting...being able to apply it to everyday society; but also be[*ing*] able to understand more about it so you could make an argument about it...like global warming...I felt more informed about it so whenever you see that stuff on the news you feel like you're more into it than you would be without it, without the education.

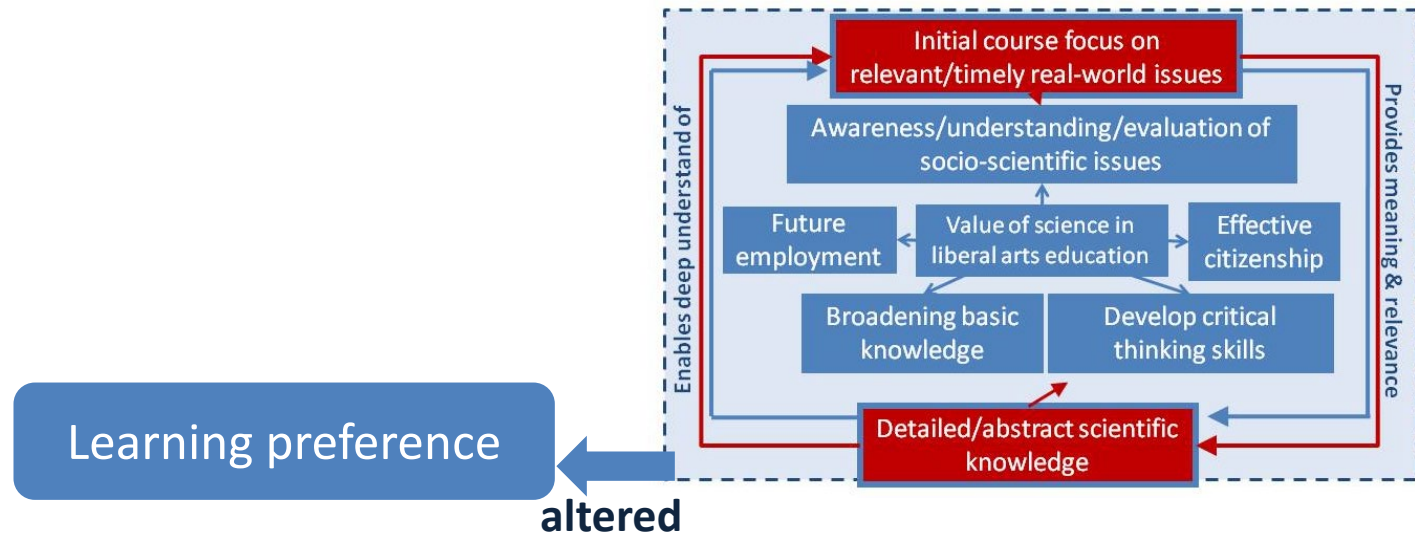
**Deonna** - Doing the case studies helped us with debate and public speaking and discussions in class and just doing extensive research so...I think I'm a better...persuasive paper writer...because of this course.





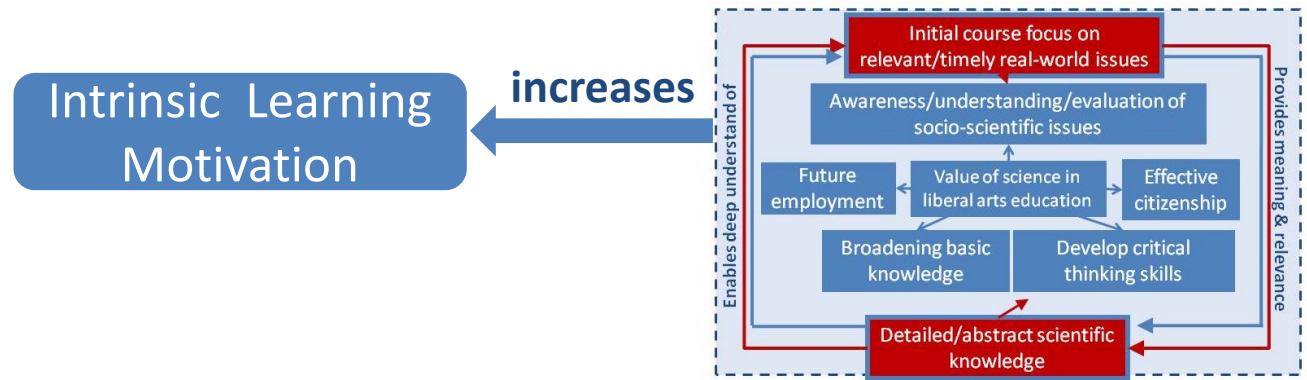
**Sarah:** It was definitely more critical thinking. There weren't just facts being fed to us and we just blindly took it. We definitely made up our own mind and we studied both sides and we learned this stuff...when you get out there in the real world you know how to think about things critically instead of just accepting what the news is telling you.

**Brittany:**...we had to do case studies about certain specific social issues or civic issues and I felt it made me consider the biological concepts as well as the social, economical costs as well. So, it made me try to think critically but incorporate everything, not just from like an economic perspective.

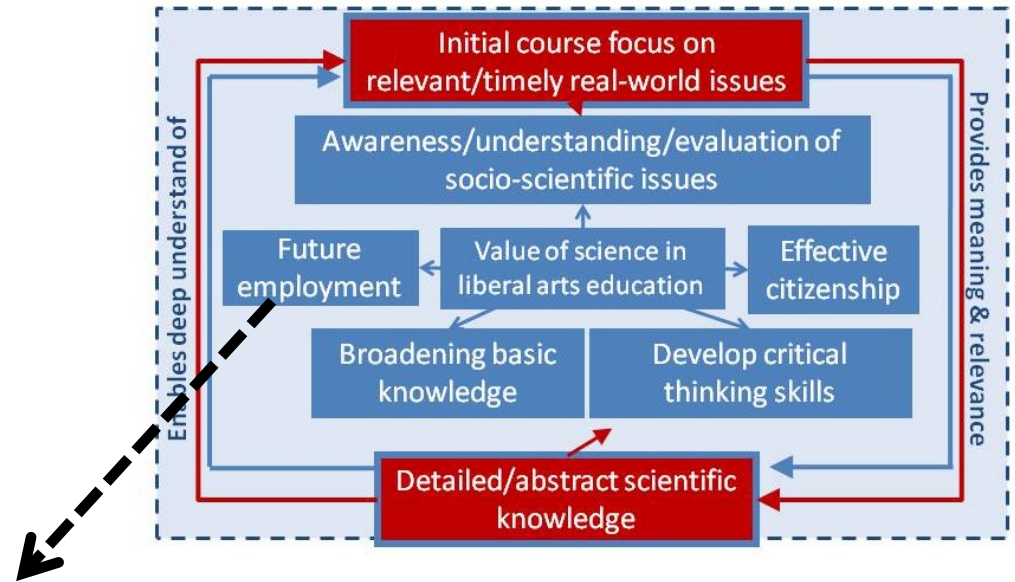


**Erin:** *Took BIOL 111 (majors' course) and BIOL 102 (non-majors)* - Comparing the two, because I know that they're definitely different in the way we addressed issues. [In] 111, I felt like I related better to facts, clear and simple. Like learn this learn this memorize this ...that's kind of what I identify more with. But it was funny, because although I liked that style of learning, I actually felt like I consumed more information and know more about specific topics and feel more comfortable with them the way we did it [*in BIOL 102*]...with relating them to civic things that are going on like with us right now so I kind of like switched my learning a little bit in this area so that's kind of interesting I thought.



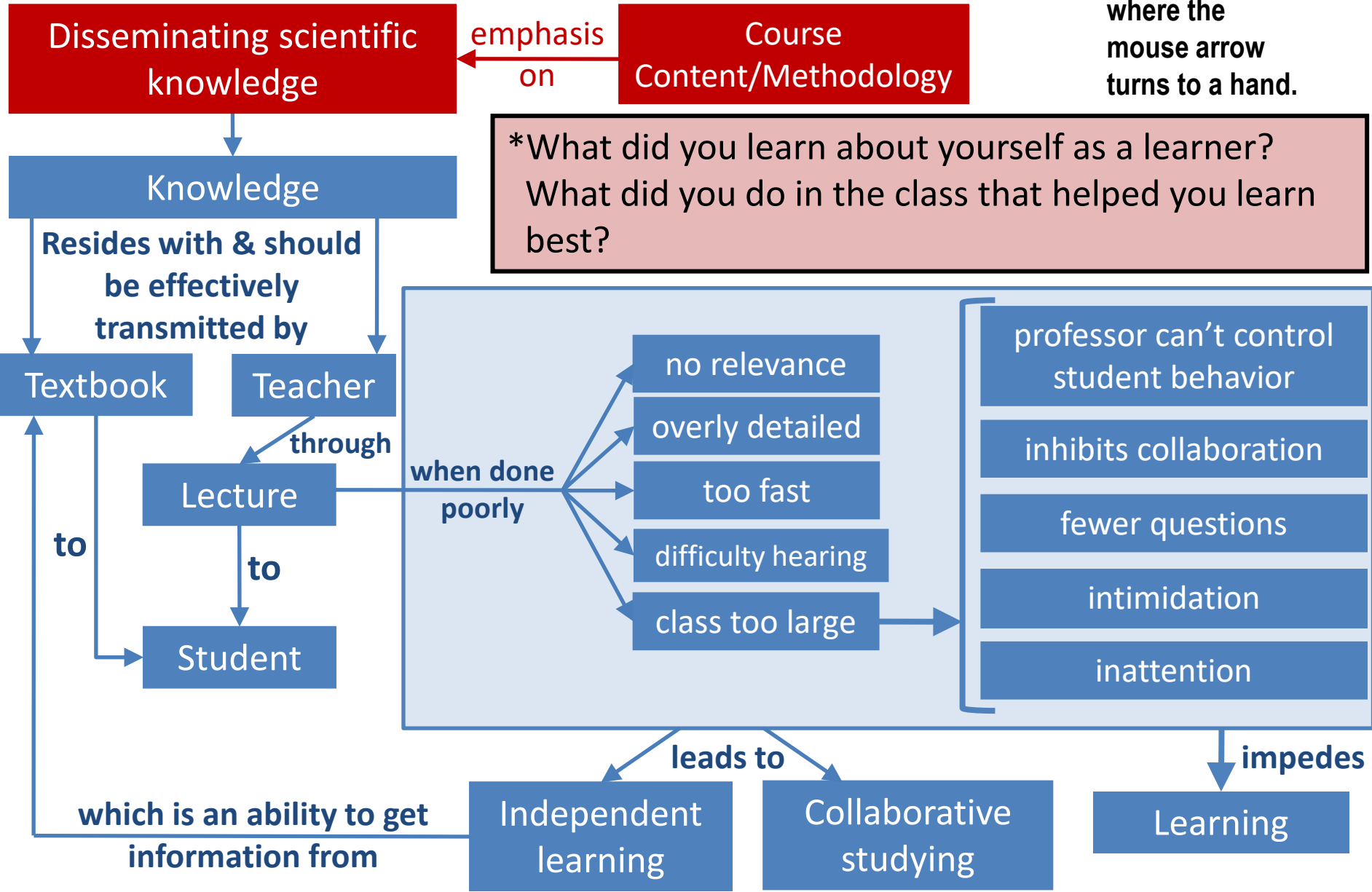


**Sarah:** I really feel like...being able to take it in the way that I did in class was so much better for me...because I would go home and tell my parents, “Oh, this is what I learned in biology and I could explain it to them. And I was like, “Oh my gosh, what’s happening?” Because I didn’t do that in high school... I didn’t do that for the last 3 years and now all of a sudden I’m doing that, and I understand it. It’s so weird that [in] my other courses were talking about stuff, [like] in communications classes...and it all fits in, and I’m like, “Oh my gosh I'm interested, oh my gosh I understand it.” That’s so much more important to me because when exams come...I have become convinced that I’m going to understand the majority of it, maybe not all of it, but a majority of it. Whereas before it was like remember it for the test, you take the test and then you just let it go.



**Allison:** [Biology] is important because that's half the reason I chose to come here because of the liberal arts education. Granted, I am a freshman coming in as undecided major. I think it's important when you graduate from college...just not to, if I want a business degree, and all four years take business classes. I think it's important to have a round spectrum of knowledge...because... it makes you better, well rounded person in the world to compete for jobs.

Click on any box or path where the mouse arrow turns to a hand.



Disseminating scientific  
knowledge

emphasis  
on

Course  
Content/Methodology

**Melissa:** The professor would print out the notes, put them online and you could print them out and bring them to class. And [in] my class it just didn't make sense the way it came out. It would be like 40 pages and just like, words. Like black and white just the whole way down, just all like jumbled together...and it was like, "okay, I'm trying to follow", you know? And then in 102 we had like slides on each page and it was like pictures and it was exactly what you saw on the screen. You just take your own little notes to the side as she was talking and it just made it so much easier...

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Disseminating scientific knowledge

emphasis on

Course Content/Methodology

Knowledge

Resides with & should be effectively transmitted by

Teacher

through

Lecture

to

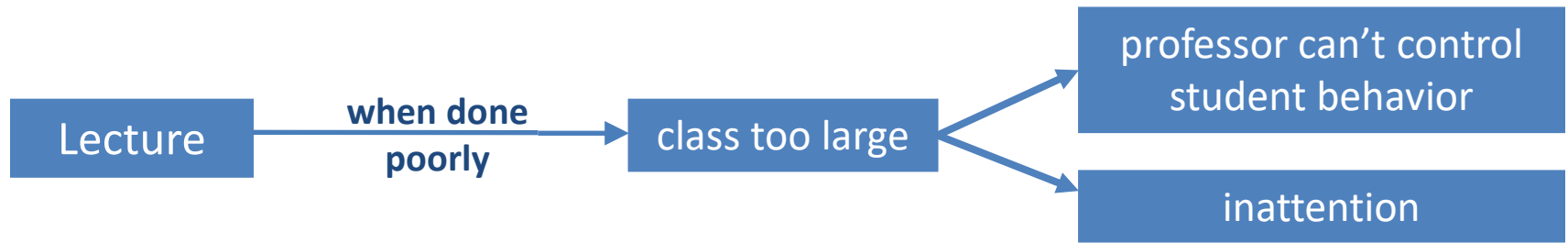
Student

**Savannah:** What helped me learn is just to have somebody very clear, very to the point, specific, able to understand...I think the classes that I've taken that had notes that go along with the lecture are very helpful, so you can look at your notes and be able to hear your professor and not have to worry about writing something down.

**Josephine...**[the professors] don't know how to control the kids and they don't know how to keep their lectures focused, they don't know how to engage the students that are there willing to learn and I think that just a, a focused lecture is something that no matter the class size, that will keep the students.

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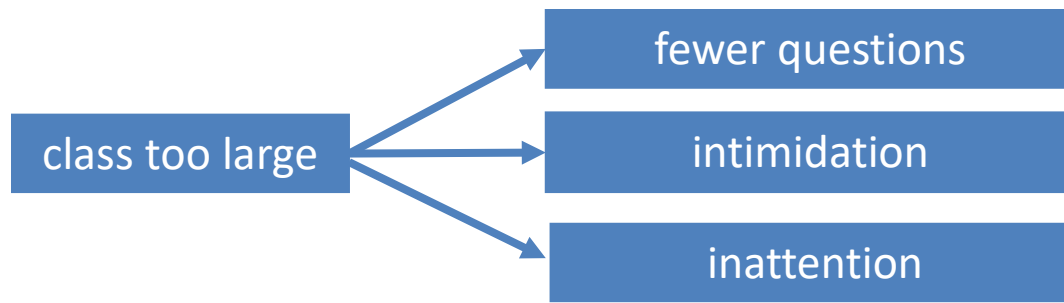
**Josephine:** I think that the professors here expect to have small classes, and the ones that are put into the big class settings, they don't know how to control the kids and they don't know how to keep their lectures focused, they don't know how to engage the students that are there willing to learn and I think that just a, a focused lecture is something that no matter the class size, that will keep the students.

class too large



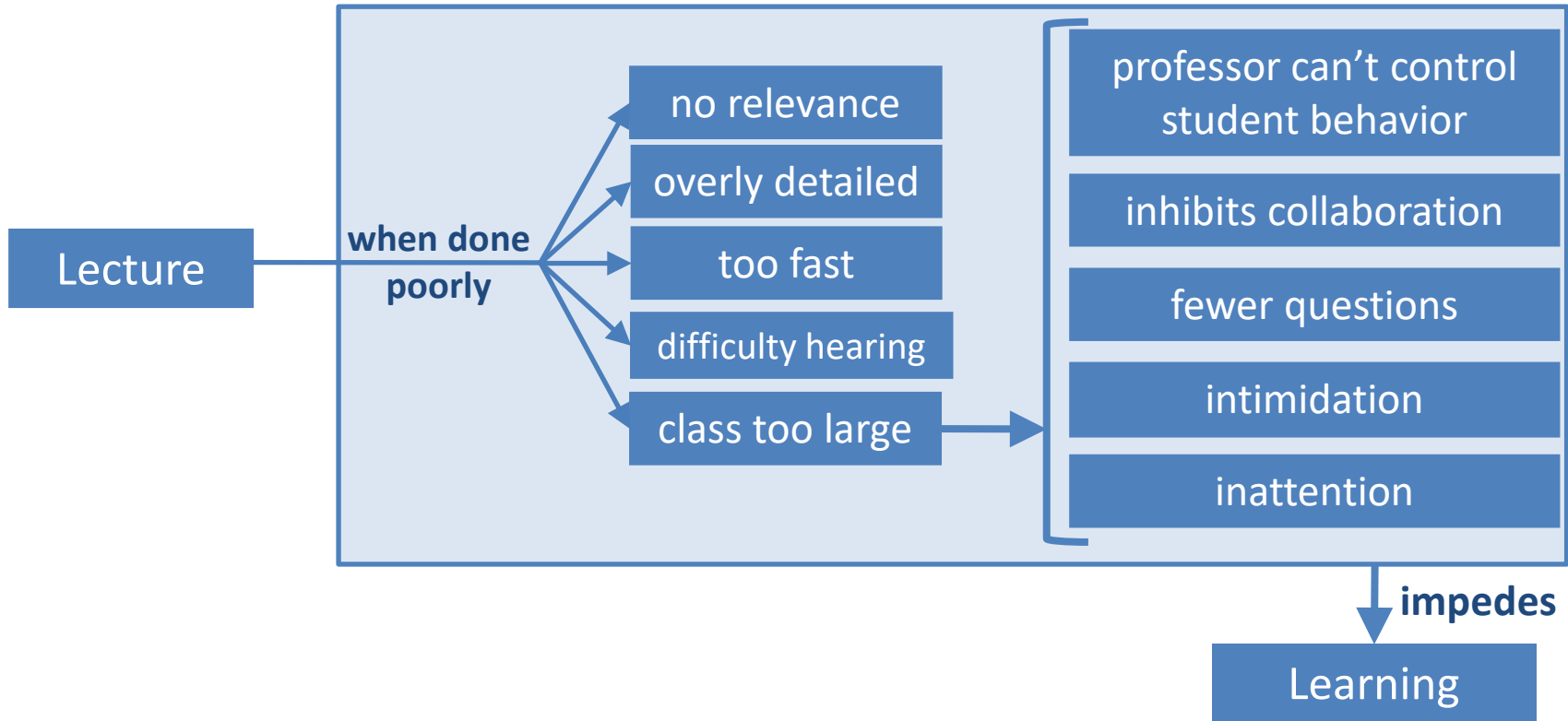
professor can't control  
student behavior

**Randy:** I think it'd be easier for an instructor to control a smaller classroom because people do tend to sit in back and [when] you're in a smaller area and you don't have as much room to spread out away from the instructor, then you're obviously gonna be...held more accountable for your behavior in class. There are people that are actually trying to make sense of what you're learning as opposed to just sitting in the back and sending text messages...(laugh).

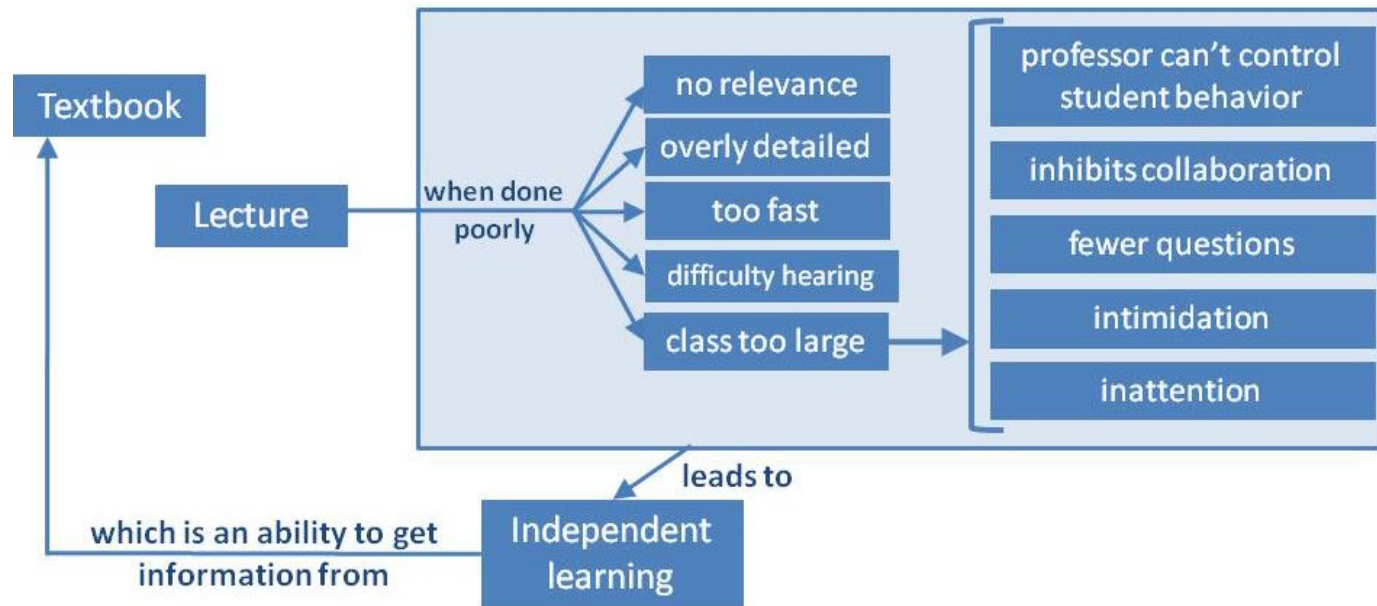


**Kristi:** That's really intimidating, when you have a huge class...you have people that aren't really concerned with learning so they talk the whole time, you're like "excuse me, can you please go back", it's really intimidating to ask to go back, and they might not mind, but you're thinking you're holding down 50 other people because you can't grasp a concept or you haven't finished writing down notes.





**Savannah:** The class...served me no justice. I could've been doing anything else. I could've been spending the time a million different ways, I mean being productive. I didn't get anything at all out of the class, the lecture itself.



**Josephine:**...because of the [poor] quality of my professor in my lectures, it forced me to learn the material he was trying to teach on my own...I've never had to work that hard on my own. I feel like there have always been times where I'll be unclear about something in a lecture and I'll go back and read the text book or find some other information that summarizes it differently or more specifically in certain areas but this was just kind of everything on my own and, it wasn't a bad thing once I realized that that's how it was gonna have to be, but it definitely did teach me to teach myself.

What did you learn about yourself as a learner?  
What did you do in the class that helped you learn best?

\*Initial course focus on relevant/timely /real-world issues

Provides meaning & relevance for

Enables deep understanding of

\*Emphasis on discovering scientific knowledge

*\*some students indicated they were surprised by this finding*

Understanding & retention of scientific concepts

Independent research skills

Communication skills

Analysis & synthesis of information

\*Self-efficacy and confidence

\*Collaboration in learning

Asking/answering questions

Leads to improved

later

initially

Frustration because not like traditional science classes

\*Note-taking not needed for learning

Writing helps with learning

\*Confidence in my own ideas

\*Teaching others helps with learning

\*Developed intrinsic motivation to learn

In-class learning feedback helps

\*Discovered new learning preference

Use of resources beyond textbook

\*Improved connection/learning in other courses

\*Initial course  
focus on  
relevant/timely  
/real-world  
issues

Provides meaning &  
relevance for

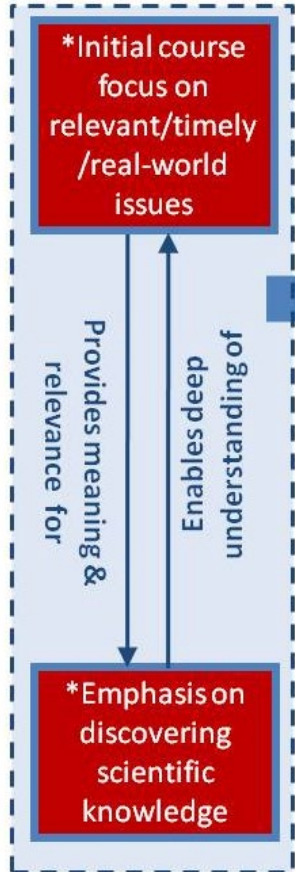
Enables deep  
understanding of

\*Emphasis on  
discovering  
scientific  
knowledge

initially

Frustration because not like  
traditional science classes

**Sarah2:** I don't know if this is common of all teachers but I know that in the beginning of the semester it was really frustrating because I knew the basics of biology but you know these case studies were a really new idea for me and just like applying stuff and it was just a lot new going on for me and I wasn't used to it.



Independent research skills

**Tori:** ... we would do outside research, our groups were divided into studying the ocean carbon cycle and we had to research on our own and find information on our own and I found that I learned a lot about it through researching on my own in the subject...I thought that was a good way to learn the subject.



**Sarah1:** And I 'd have little questions pertaining to the topic and my teacher was really big on not giving us the answer and at the same time encouraging us to go outside and find out and she'd actually follow up and she'd ask you, "Did look that up and what did you find out?" ...I feel like when we talked about stuff it was a really open discussion...we would... speculate on a topic, get everyone's opinions.... And I really liked that because it was really helpful...I would go look up that answer and it would motivate me to go find out.



**Emily:** I loved the fact that we did not have to rely on the text book for everything we were able to [do] the critical thinking...I think [it] increased so much for me and the problem solving...just the fact that you were able to go through a problem, and even though you might make mistakes, or you might think something at first you were able to get the answers...and so I think because of that I actually improved in my other classes...being able to do the same thing, being able to go out and explore and find it myself instead of having to say, "Oh, the textbook doesn't say it", and just become lost without it.





**Katie:** I learned how to work with a group. Group work was never something I had done before and it surprised me how well it worked for me. I really enjoyed working with projects and figuring out...how to get stuff done in a timely manner...I'd hold like class discussions. That was really helpful. I feel like that is really what science is about, talking about ideas with other people. So, that is something I really found helpful.



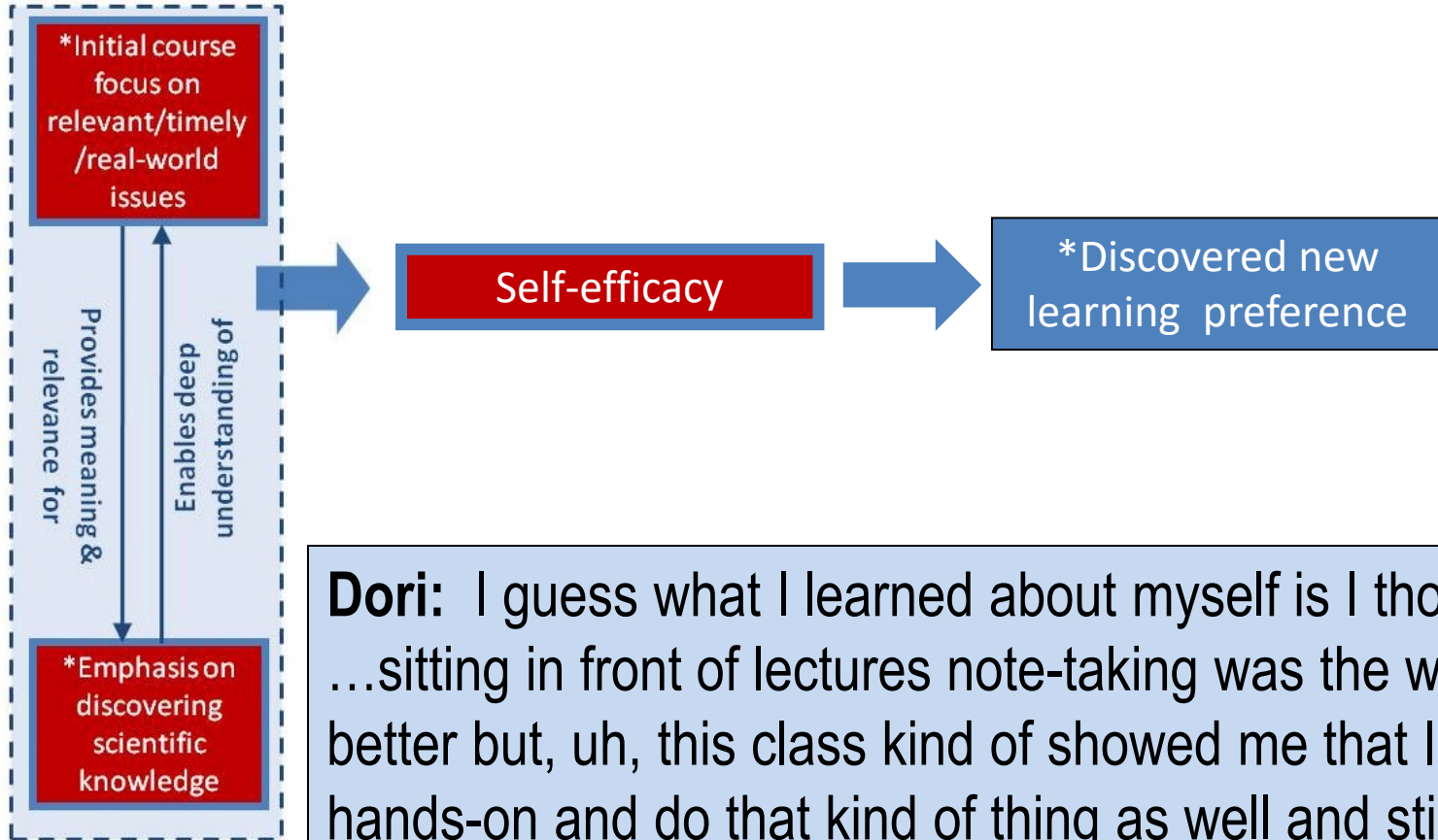


*\*some students indicated they were surprised by this finding*

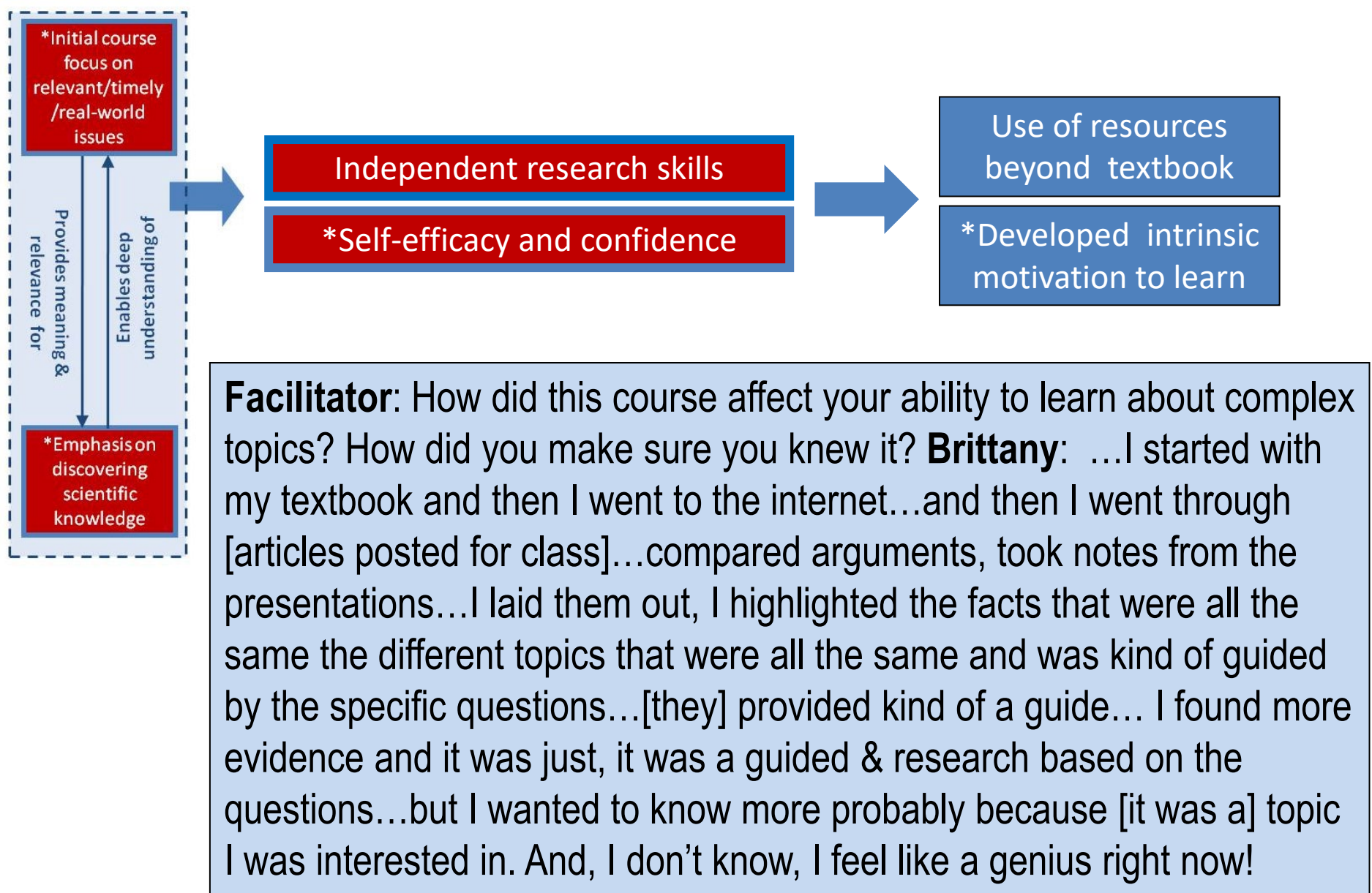
**Chase:** In every other class I just sit there and write down every single thing that comes out of my teacher's mouth. My notebook is not even half-way filled from this class and that really surprises me because I would always take notes. In this class I was able to just discuss things and I realize that I remembered it I remembered it just as well or better because I...talked about it in class, and that surprised me.



**Sarah2:** I kind of found out that a lot of times I want to say things but I don't because I think that they're wrong or someone's going to laugh or [it's] stupid ...but a lot of things that I did say had a lot of impact on what we were talking about or a lot of the questions that I asked really pertained to stuff and I found out that sometimes I am right when I think that I'm wrong and that sometimes my ideas are ok.



**Dori:** I guess what I learned about myself is I thought that ...sitting in front of lectures note-taking was the way I learned better but, uh, this class kind of showed me that I can be hands-on and do that kind of thing as well and still do well. And, so, I have different qualities that as a student that I think I'm capable of.



# Traditional (lecture/lab)

Click on any box or path where the mouse arrow turns to a hand.

Asking questions

Seeking to explain natural phenomena

Hypothesis testing

Theory Use & Development etc..

What do scientists do, and what do they produce?

How was lab like/different from science?

Finding information to back up hypothesis

through

Observation & Experimentation

not like science because students are NOT

leads to

Proof

Discovering new knowledge

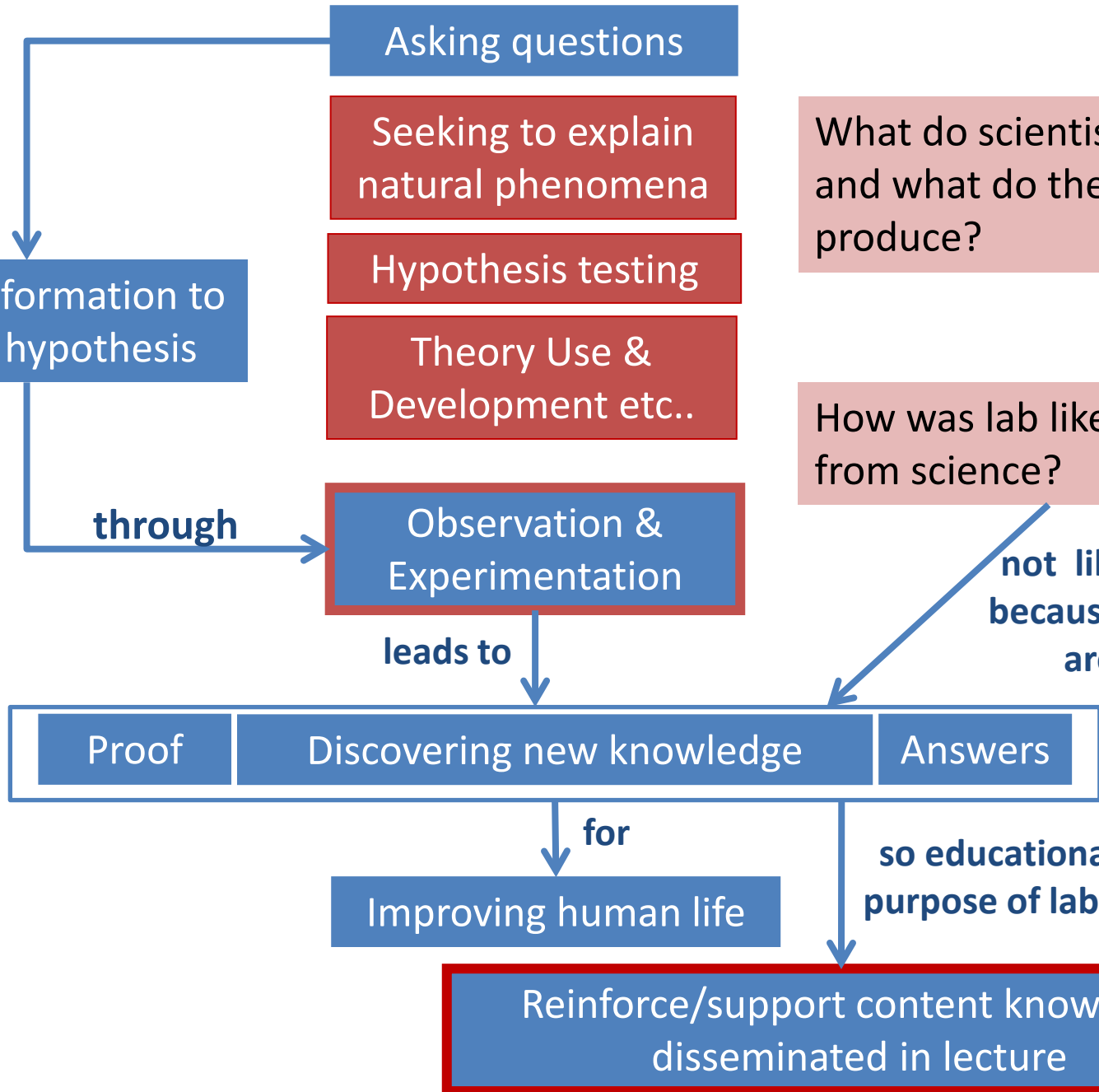
Answers

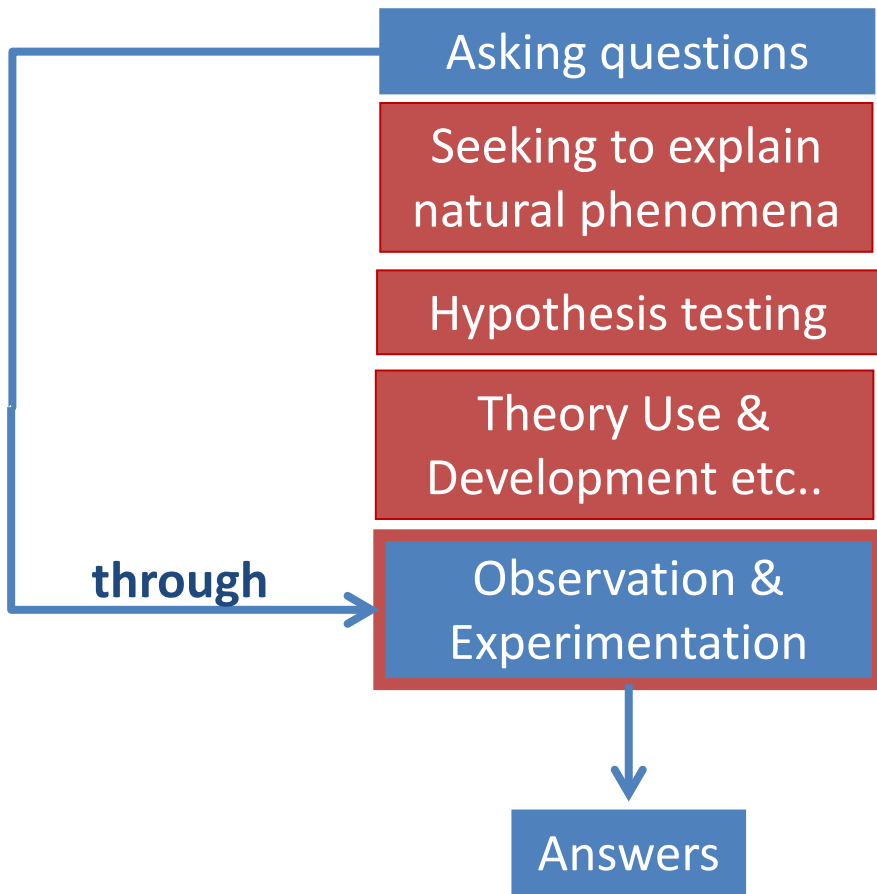
for

Improving human life

so educational purpose of lab is

Reinforce/support content knowledge disseminated in lecture





**Josephine:** [Labs]...teach you how to do things other than to just sit in a class and learn and regurgitate information and they give people who learn in a more kinesthetic way a hands-on [experience]... maybe you weren't supposed to come away with the fact that on a piece of paper if you put lipids on, then it will turn a certain color. You're supposed figure out how, if you had a question about something or if you read some results, you could use some of your knowledge from experiences to know how they came about with certain answers and how things are found out, not necessarily exactly what you found out is all that important...

Asking questions

Finding information to  
back up hypothesis

**Savannah** – hypothesize about a lot of things and then they try to find information to back up what they think is happening or what's gonna happen.

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How was lab like/different from science?

not like science because students are NOT

Proof

Discovering new knowledge

Answers

**Savannah** - I think most scientists...are looking for new things and I think what we did was to learn what's already known. So it wasn't in a sense really research or what I would consider research..., I was also really disappointed in the labs...it was just a lot that we did that just wasn't really that exciting.

**Lindsay** - ...we're not really coming up with anything on our own, like John was saying, we're just like doing something in a book that's been done numerous times. We're not ...applying anything that we've learned. We're just... following a procedure, which is like part of the scientific method I guess but we're not coming up with our own ideas. I guess we're only in an intro class so I guess we wouldn't...

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How was lab like/different from science?

not like science because students are NOT



Improving human life

**Kristi** - when I think of scientists I think of like medical breakthroughs and new technology for chemo patients, hospital-type things...I wanted to go into oncology and I met with a couple scientists...and they did a lot of research and a lot of hands-on things that a lot of people really don't care about. But I think it really benefits people who have a disease or...I'm just thinking like more medical breakthroughs and more technology and like with stem cell or other diseases. **Genevieve** - asking questions and proving things, um, not really proving necessarily, but to improve life in general I think for humans, animals, plants, um, whatever.

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How was lab like/different from science?

not like science because students are NOT



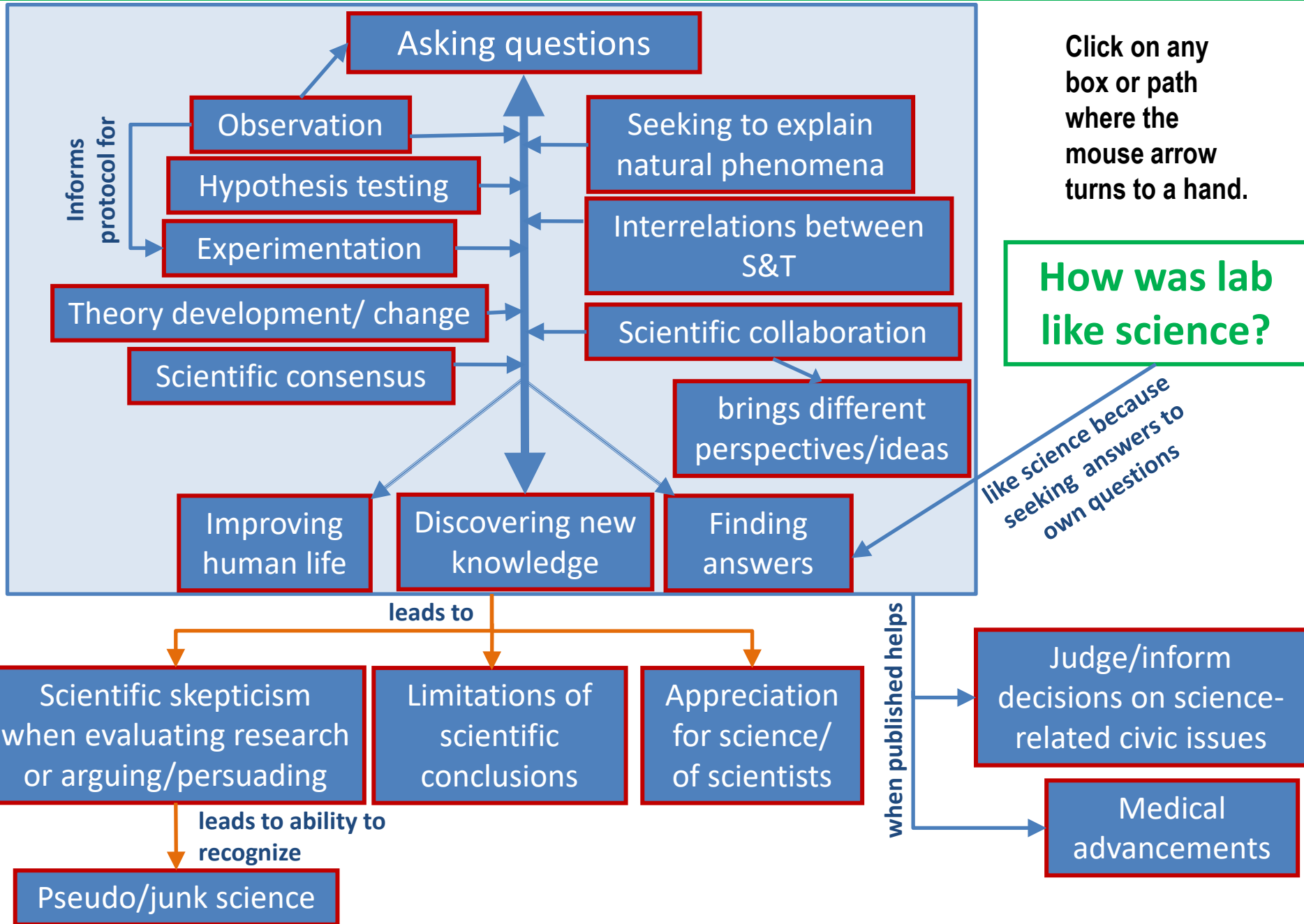
so educational purpose of lab is

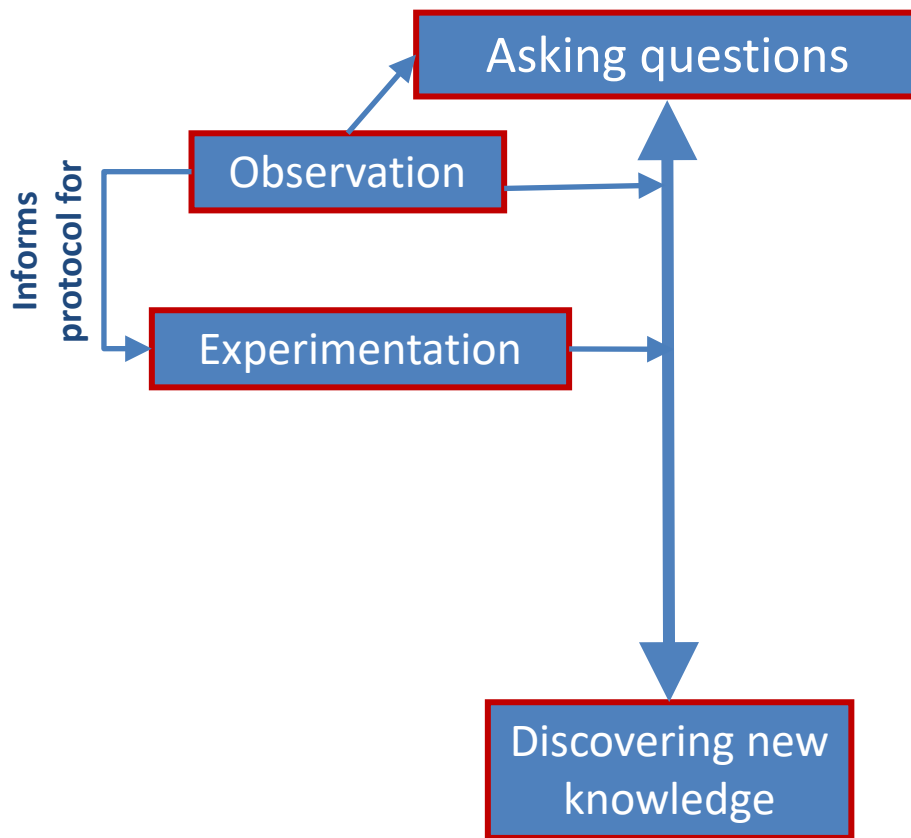
Reinforce/support content knowledge disseminated in lecture

**Kristi** - It was really hard for me to like why do I need to do this, I'm not learning this in my lecture, why do I need to learn about lipids and whether it turns the, ya know Burret's test blue, if it's positive for lipid or positive for whatever. I didn't like that at all...

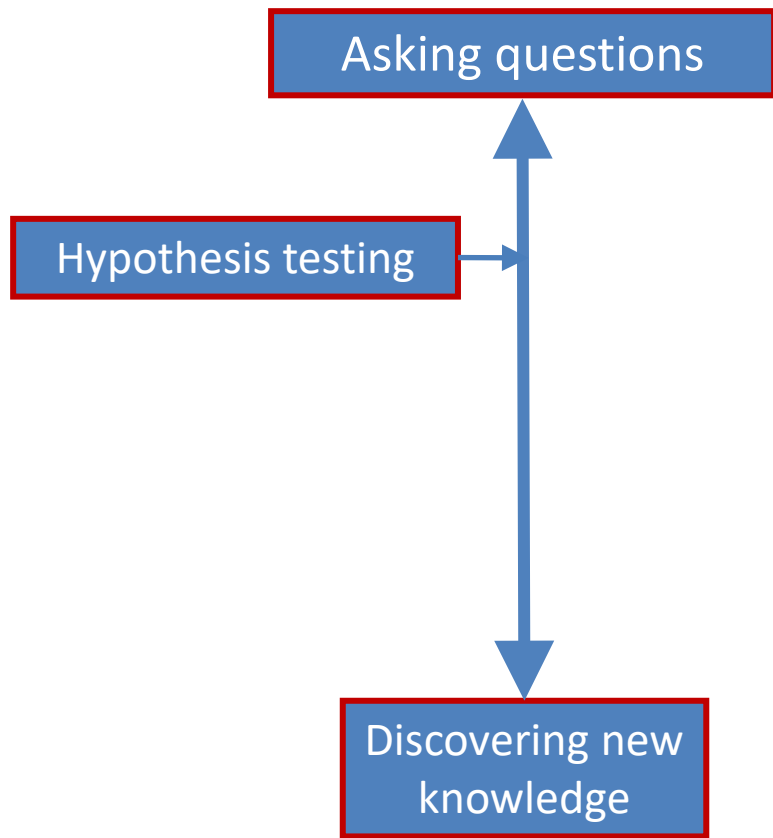
**Randy:** It would've been better if the two worked together in time [and] in schedule, so that you're hearing, you're learning about something and then you're actually going to do hands-on with it, because then I think it would solidify more in the mind,... then do hands-on and then going back and learning about the details when you go to your class.

# PBL class/Inquiry lab





**Erin:** ...in the butterfly experiment we knew that we were creating ...coming up with the wings, the wingspan the colors that go to the pattern if there was a pattern, kind of going off what we probably already knew like creating darker wings would attract more sunlight or more heat. But at the same time...we tested it and we saw the visual like evidence of that...



**Savannah:** ...most scientists' objective is to question a part of life and test it and even if there is already a hypothesis known in the scientific community even trying to disprove it because that is what scientists continuously do...try to make sure that the hypotheses were supported by their facts aren't just one-case incidences, trying to get like more evidence to back up or disprove.

**Emily** - I think that in the class it was more finding information find your viewpoint and how do you express that you know like...biological terms...and in the lab I think that it was more of the actual like research and testing and coming up with hypothesis.

Asking questions



Interrelations between S&T

Discovering new knowledge

**Savannah**:...elaborating on the results that [scientists] found because new technology allows us to make more breakthroughs in science and to discover new things.

Asking questions

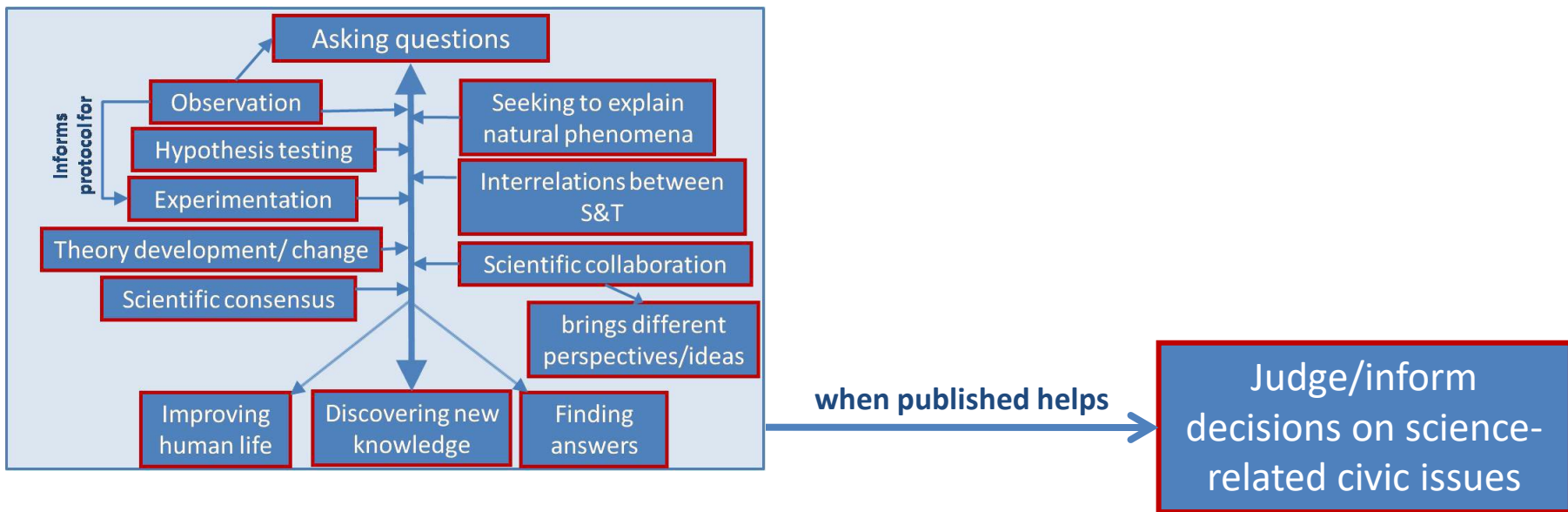


Improving human life

Discovering new knowledge

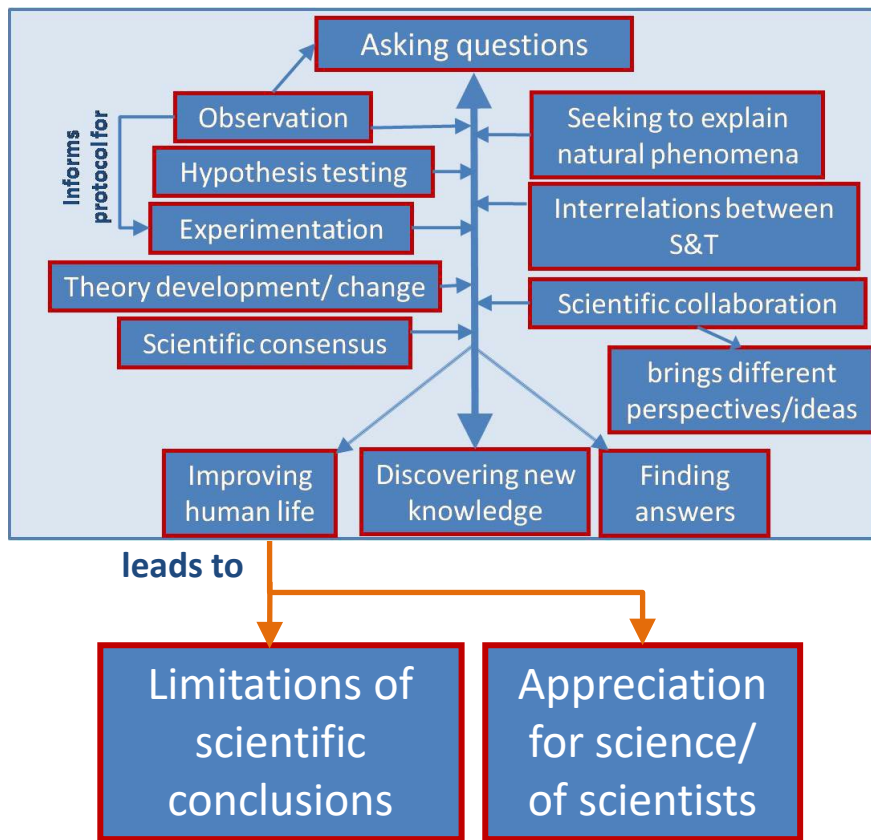
**Claire** –to advance humans altogether because a lot of the things they do like observe animals and they want to understand how the animals take care of our environment because animals keep the environment obviously moving and the environment keep us healthy like its' kind of like boils down to preserving in some way...

**Becca** - medical technologies/cures are more beneficial to society than basic science research, and science should be done to better society.

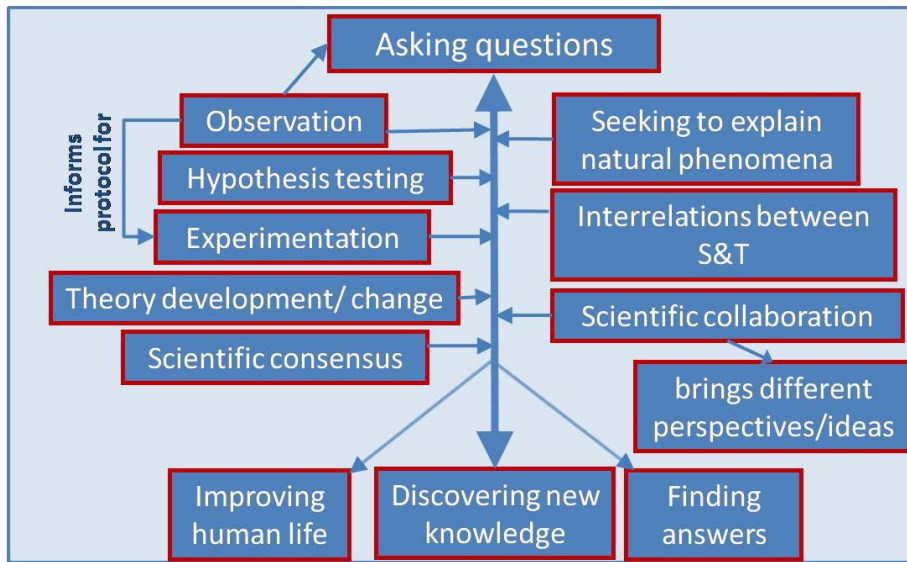


**Brittany** - I think to that sometimes what they create with the research [is] published...it gives people kind of not a standard but something to judge their decision by especially in reference to global warming...I feel like whatever they put out there the media or the people can read the people will be like oh I do agree with that because of this evidence or no I don't agree with that because of such and such. So it's kind of like, not a standard, but just put it out there where you can base your decision on.





**Allison:** I came into the lab thinking ‘oh we’re kind of like fake scientists’ like we can mess up and like not be precise and it’s not going to be the end of the world type things. But, it kind of made me appreciate like how real professional scientists have to be meticulous and precise and retest their findings over and over again and come up with the perfect procedure and methods to you know get the most accurate results possible ... like the big experiment we had to do; one of the last questions was ‘what could you change to like make it better?’ and there were so many things you could do to make the experiment more valid. It just kind of made me realize how much work goes into real science, like actually doing something important like cancer research...



leads to

Scientific skepticism  
when evaluating research  
or arguing/persuading

leads to ability to  
recognize

Pseudo/junk science

**Allison:** After taking this course I've learned about junk science and stuff that isn't credible and that there's a lot of [it]....I've seen, through doing research on certain projects, a lot of the research out there and finding I'm kind of skeptical about [it]. How the survey or the experiment was conducted, enough people were tested or stuff even just through lab. Like, we had to come up with an experiment and test stuff and come up with a conclusion; you kind of just question, like, do I believe that or not.