Electronic Supplementary Material (ESI) for Chemistry Education Research and Practice.
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Electronic Supplementary Material (ESI) for:

Metacognitive Regulation in Organic Chemistry Students: How and Why Students Use Metacognitive Strategies When Predicting Reactivity

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Appendix S1: Interview Protocol

Introduction and Background Questions:

Thanks so much for coming, I really appreciate your help. First, I just want to start off with a couple background questions and some general questions about your experience with organic chemistry.

Undergraduates:

1. What organic chemistry courses have you taken so far?
2. What is your year in school and intended major?

Graduate Students:

1. What year are you in your program?
2. Which research group are you in?
    - How long have you been working with them?
    - Can you briefly (~1-2 min) describe your project?
3. Have you taken any organic courses in graduate school?
    - If yes, what were they?
    - If no, when was the last organic course you took?
4. Have you taught any organic chemistry courses?
    - If yes, what were they?

Instructions for Think-Aloud Portion:

Part of what I'm trying to study is the detailed thought processes that go on in people's minds while they are working on solving typical organic chemistry problems. What I'm going to have you do is work through a predict-the-product organic problem, and I want you to vocalize your thoughts as you have them, to the best of your ability.

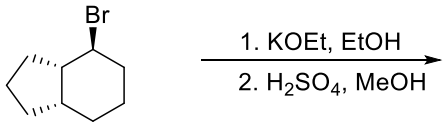
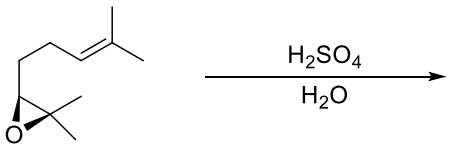
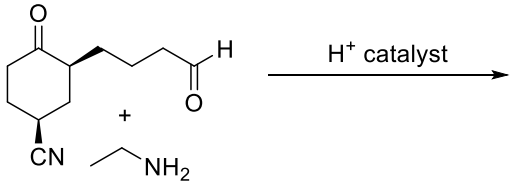
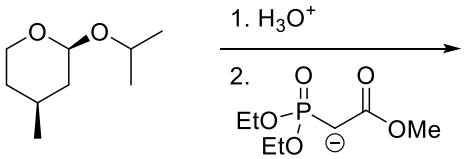
You are not being evaluated on whether you get the "right" answer – there might not even be one specific "right" answer. Mainly what I'm hoping to get insight into is how people end up at a variety of answers, what the thought processes are that lead to those answers, and what kinds of things people are considering that don't make it onto the page or into their "final answer."

Do you have any questions for me?

Please vocalize your thoughts as you have them, and let me know when you have finished working on the problem. If you are completely unsure and don't have thoughts on how to proceed further, just give me your best guess. We're trying to get at the best approximation of the thoughts you'd have if you were sitting alone, working on this problem without any cameras. Please try to keep talking, even if your thoughts aren't fully formed yet.

First Think-Aloud Problem:

Each student works on two problems over the course of the interview. They work on the first problem before the discussion portion of the interview. The order of the problems is chosen randomly prior to the interview.

Problems Completed by Organic Chemistry I Students	
	
Problems Completed by Organic Chemistry II Students and Graduate Students	
	

Survey Completed After the Student Finishes the First Problem:

Great job! The next thing I'd like you to do is fill out this short survey. After you've filled out the survey, we'll discuss your answers and then talk more about how you approach organic chemistry problems.

The student is sent a link to a survey hosted on Qualtrics. Once they finish it, they engage in a guided discussion about their problem-solving strategies.

Discussion Questions:

- There are many different strategies mentioned on this survey.
  - Can you explain why you do use [strategies the student said they used often]?
  - Can you explain why you don't use [strategies the student said they did not often use]?
- Are there some strategies you use all the time, and some you only use when you're having trouble with a problem?
- What is your strategy when solving a problem on an exam?
- Would your strategy change at all if it was a problem on a homework assignment?
- Does time pressure lead you to change your strategy? What about access to notes?
- How did you come to use the strategies you use?

Second Think-Aloud Problem and Accompanying Survey:

The student completes a second problem while vocalizing their thoughts. After they finish, the student is sent a link to a second survey hosted on Qualtrics.

Thank you so much for completing that survey and for participating in this interview. Please let me know if you have any questions for me before we end the interview.

Appendix S2: Survey Taken on Qualtrics after Interview Problems

Notes:

- *The answer choices were the same for each question in Part 1. For brevity, these answer choices are only displayed for the first item in this Appendix.*
- *After the first interview problem, students completed both Part 1 and Part 2. After the second interview problem, students completed only Part 2.*

Part 1: Please indicate how frequently you used the following strategies when solving organic chemistry problems on homework and on exams for the most recent course you have taken that was related to organic chemistry. Choose the option that best represents your actual behavior when solving problems, not what your behavior would have ideally been if you had more time, had studied more, etc.

1. I set goals (ex. "I need to make this bond," or "I want to make this functional group") before attempting a solution.

	Always	Most of the time	Sometimes	Rarely or Never
While working on homework	○	○	○	○
While working on exams	○	○	○	○

2. Before I start working on a problem, I sort through the information in the problem to determine what is relevant.
3. Before I start working on a problem, I look for any reactions I recognize.
4. I reflect upon things I know that are relevant to a problem before I start working.
5. I try to relate unfamiliar problems with previous problems I've encountered.
6. I jot down my ideas or things I know that are related to the problem before attempting a solution.
7. I make predictions about what will happen before I start working on a problem.
8. I brainstorm multiple ways to solve a problem before I actually start solving it.
9. I consider whether my proposed steps are reasonable before I actually start solving a problem.
10. When I'm the middle of working on a problem, I pause to consider whether there is another way to solve it.
11. While I'm working on a problem, I pause to consider whether I am making progress towards my goals.
12. I pause to consider whether what I am doing is correct while I'm working on a problem.
13. I take note of what I am uncertain about as I work on a problem.
14. As I work on a problem, I periodically check back over what I have done so far to make sure my overall approach is reasonable.
15. I think about whether my answer is reasonable after I finish a problem.
16. I make sure that my solution actually answers the question.
17. I check back over my work once I finish a problem to make sure I didn’t make any mistakes.
18. Once I reach an answer, I check to see that it agrees with what I predicted.
19. Once I finish a problem, I summarize the main take-away lesson I have learned.
20. After I finish a problem, I consider how I might change my approach for future problems.

Part 2: Please indicate whether you used these strategies when working on the interview problem.

	Yes	No
I set goals (ex. "I need to make this bond," or "I want to make this functional group") before attempting a solution.	○	○
Before I started working, I sorted through the information in the problem to determine what is relevant.	○	○
Before I started working, I looked for any reactions I recognized.	○	○
I reflected upon things I know that are relevant to the problem before I started working.	○	○
I tried to relate unfamiliar problems with previous problems I've encountered.	○	○
I jotted down my ideas or things I know that are related to the problem before attempting a solution.	○	○
I made predictions about what would happen before I started working on the problem.	○	○
I brainstormed multiple ways to solve a problem before I actually started solving it.	○	○
I considered whether my proposed steps were reasonable before I actually started solving the problem.	○	○
When I was in the middle of working on the problem, I paused to consider whether there was another way to solve it.	○	○
While I was working on the problem, I paused to consider whether I was making progress towards my goals.	○	○
I paused to consider whether what I was doing was correct while I was working on the problem.	○	○
I took note of what I was uncertain about as I worked on the problem.	○	○
As I worked on the problem, I periodically checked back over what I had done so far to make sure my overall approach was reasonable.	○	○
I thought about whether my answer was reasonable after I finished the problem.	○	○
I made sure that my solution actually answered the question.	○	○
I checked back over my work after I finished the problem to make sure I didn’t make any mistakes.	○	○
Once I reached an answer, I checked to see that it agreed with what I predicted.	○	○
Once I finished the problem, I summarized the main take-away lesson I learned.	○	○
After I finished the problem, I considered how I might change my approach for future problems.	○	○

Appendix S3: Metacognitive Strategies Coding Scheme

General Notes on Usage of Planning, Monitoring, and Evaluation Codes:

- Planning Codes: These should only be assigned before the student draws their first new chemical structure. If the problem consists of multiple steps, planning codes can also be assigned when the student begins talking about the second step of the reaction.
- Monitoring Codes: These should only be assigned after the student has started drawing their first new chemical structure, but has not yet reached an answer.
- Evaluation Codes: These should only be assigned after the student has reached their final answer, or what they initially stated was their answer if they then changed their mind about their answer.

Code	Description	Example(s)
Set Goals	*"I set goals (ex. "I need to make this bond" or "I want to make this functional group") before attempting a solution."* The student states something they want or think they'll need to do to answer the question.	• "So somehow... I guess I have to make that into a carbonyl" • "I have to figure out where it would attack and why this acid would make it attack there."
Sort Relevant Info	*"Before I started working on the problem, I sorted through the information in the problem to determine what was relevant."* The student verbally identifies, highlights, or circles instructions, reagents, functional groups, etc. that they notice in the problem statement.	• "Ok so I see a lot of carbons here" • "I see a double bond" • *Student circles aldehyde* • *Student highlights "stereochemistry" in problem statement*
Look for Reactions Recognized	*"Before I start working on a problem, I look for any reactions I recognize."* The student identifies or states that they are looking for known reactions.	• "This is kind of like a Wittig" • "The first thing I would say...is does it look like anything I'm immediately familiar with, anything I know how to do without working it out."
Reflect Relevant Knowledge	*"I reflected upon things I know that are relevant to the problem before I started working."* The student states what they know about reactions or structural features they've identified in the problem.	• "The Wittig-type would give the double bond here" • "I know oxygen is a pretty good nucleophile" • "We learned this is the trans"
Relate to Previous Problems	*"I tried to relate unfamiliar problems with previous problems I've encountered"* The student refers back to a problem they had previously solved and compares it to the problem they are currently working on.	• "My first prediction is that this oxygen right here is going to get a hydrogen from the sulfate. And why I did that is because I think I've seen this in a past question."
Make Predictions	*"I made predictions about what would happen before I started working on the problem."* The student makes a prediction about what reactivity will occur beginning from the starting material (or an intermediate product in the case of a multi-step reaction).	• "This presumably would hydrolyze the acetal to get back to either a hemiacetal or an aldehyde" • "You're probably making an alkene" • "First this will make an imine"

Jot Down Ideas	*"I jotted down my ideas or things I know that are related to the problem before attempting a solution."* At the beginning of the problem, the student writes downs things they know or adds other written annotations to the problem.	• *Student writes "strong acid" beside H_2SO_4* • *Student writes "1. open the epoxide 2. methyl shift"* • *Student writes "6 memb ring?"*
Brainstorm Multiple Ways	*"I brainstormed multiple ways to solve the problem before I actually started solving it."* The student proposes multiple possible ways to solve the problem, at the beginning of the problem-solving process.	• I feel like there's many things I could do here. I feel like I could do either like maybe open the epoxide, or I could maybe do a methyl shift
Consider If Plan Reasonable	*"I considered whether my proposed steps were reasonable before I actually started solving the problem."* The student makes a judgement about whether their proposed steps are correct or likely, before they draw their first new structure.	• "Right away I think 'it's acid so it's going to protonate the amine'…but that's not really a useful reaction because it's just going to sit there."
Consider Another Way	*"While I was working on a problem, I paused to consider whether there was another way to solve it."* After they have started down one path, the student considers an alternate chemical path or an alternate problem-solving approach.	• "Maybe I'll just try to do the protonation of the other one and see what happens" • "Hm, maybe I should think more about the mechanism"
Monitor Progress Towards Goals	*"I paused to consider whether I was making progress towards my goals as I worked on the problem."* The student considers whether what they have done so far has gotten them closer to a goal they had previously stated or considers what they still need to do in order to achieve their goals/continue making progress.	• "Ok so now we're catalytic in acid" (Note: Student previously set a goal to find a way to make the reaction catalytic in acid, and they're confirming that they've done that) • "I'm just trying to make a carbonyl group, so would that help?" • "That's probably not going to get me anywhere useful for this."
Monitor Correctness	*"I paused to consider whether what I was doing was correct as I worked on the problem."* The student asks themselves whether something is correct, or states that something they've done or are proposing to do is right/reasonable or wrong/unreasonable.	• "That leaves a positive charge there, so you don't want to do that" • " This looks so wrong" • "This is kind of reasonable" • "I think this works"
Note Uncertainty	*"I took note of what I was uncertain about as I worked on the problem."* The student states what they are not sure about or what they do not know.	• "And then I am a little stuck on what to do with the second solvent in this first step." • "I don't have a periodic table so I'm not exactly sure if sulfur is the one that would be donating electrons."

Periodically Check If Reasonable	*"As I was working on the problem, I periodically checked back over what I had done so far to make sure my overall approach was reasonable."* The student looks back over what they've done so far to confirm that their steps were reasonable.	• "I like that step, and I like that step. I'm a little iffy about these steps." • "Ok, let's see. Do I like this? Let me think. Uh-huh. Am I forgetting anything?" (Note: They are checking back on what they've done so far, in the middle of the problem)
Consider If Answer Reasonable	*"I thought about whether my answer was reasonable after I finished the problem."* Once they have reached an answer, the student states whether they think their answer is correct or reasonable.	• "It doesn't look that bad, hm, ok I think I'm happy with it" • "I don't agree with the product. Because that looks off."
Check if Answered Question	*"I made sure that my solution actually answered the question."* The student refers back to the question statement to make sure that they followed the directions or that their answer fulfills all components of the prompt.	• "So am I happy with that? Let's look. Major products. I want to say this is the major product." (Note: They refer back to the instructions, which said to predict the major products.)
Check For Mistakes	*"I checked back over my work after finishing the problem to make sure I didn't make any mistakes."* The student goes over what they've done to make sure their answer is correct and free of mistakes.	• "Then count my atoms just to make sure I didn't miss anything. This one's here, this one's right here." • "Is there anything else that I'm missing? Charges? Oxygen has a good charge, all the other ones have a good charge. Ok."
Check If Agreed With Prediction	*"Once I reached an answer, I checked to see that it agreed with what I predicted."* After reaching an answer, the student refers back to a prediction that they had made during the problem and considers whether their answer agrees with that prediction.	• "So I think this is my final answer. I also said there would be no acid-base, but water is there so maybe?" (Note: This student had predicted there would be no acid-base chemistry involved in the reaction. They are referring back to this prediction.)
Summarize Main Takeaways	*"Once I finished the problem, I summarized the main take-away lesson I learned."* After reaching an answer, the student considers what they learned from the problem.	• "There's a divergence that could give you that product, but I just kept going with mine. I see that you have to draw your product and then really sit and think about it."
Consider Changes For Future	*"After I finished the problem, I considered how I might change my approach for future problems."* The student suggests a way that they could change or improve the way they approach problem solving in the future.	• A possible example would be a student stating that they should check their work more in the future.

Appendix S4: Reasons for Using or Not Using Metacognitive Strategies Coding Scheme

Reasons for Using Strategies:

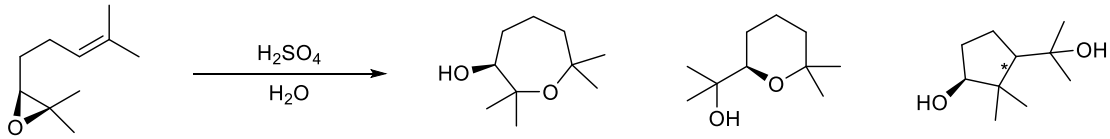
Code	Description	Example
Builds confidence	The student uses this strategy because it helps them feel more confident in their answer or thought process.	"If I see something unfamiliar and I think, you know, how is this similar to something I've done before...that'll make me feel a lot more confident."
Many reactions to consider	The student uses this strategy because they recognize that a wide variety of reactions or types of reactivity exist and could possibly be relevant to the problem.	"The more organic chem classes you take, you learn a lot more reactions, and I think having that much information to go through is kind of a lot. And so being able to break it down into smaller chunks I find very useful."
Helps them learn/ improve	The student uses this strategy because it helps them learn or improve their knowledge or problem-solving skills.	"I thought it was important for me to summarize what did I learn from the solution...because that'll help me in the future when I encounter this type of problem."
Avoid wasting time/effort	The student uses this strategy because it helps them avoid wasting time or effort during the problem-solving process.	"If I'm not certain about something, I don't want to waste too much time on it. And so I'll star it, try to guess something, and then come back to it at the end if I have time."
Get started/ narrow focus	The student uses this strategy because it helps them get started on the problem or narrow their focus to certain pathways.	"Identifying specifically the bonds that need to be made or broken really helps you narrow the focus of a 1000 molecular weight molecule down to the 5 or 6 atoms that are actually relevant to the question and that takes out a lot of options."
Keeps them on right track	The student uses this strategy because it helps them stay on the right path and continue making progress towards an answer.	"It helps with making sure you're going down the right path, making sure you're getting the right steps. Especially when I get stuck, I think just looking at what I need to get to is a key thing I do."
Keeps them from forgetting	The student uses this strategy because it helps prevent them from forgetting an idea or piece of information.	"Yeah, I would sometimes do that because I don't want to just rely on my brain to remember everything."
Someone encouraged use	The student uses this strategy because another person, such as an instructor or tutor, encouraged them to use this strategy.	"I definitely always look at what bond I need to make and what functional group I need to make if there is a product written out for me. Because not only [my professor], but my [teaching assistant], reiterated that a lot. So that's just how I learned o-chem."
Helps avoid mistakes	The student uses this strategy because it helps them avoid making mistakes.	"One of my biggest mistakes could be with forgetting atoms or incorrect stereochemistry. So I made sure, for this example, to double check my stereochemistry, and I was trying to count the carbons in one of the chains in the ring that opened."

Reasons for Not Using Strategies:

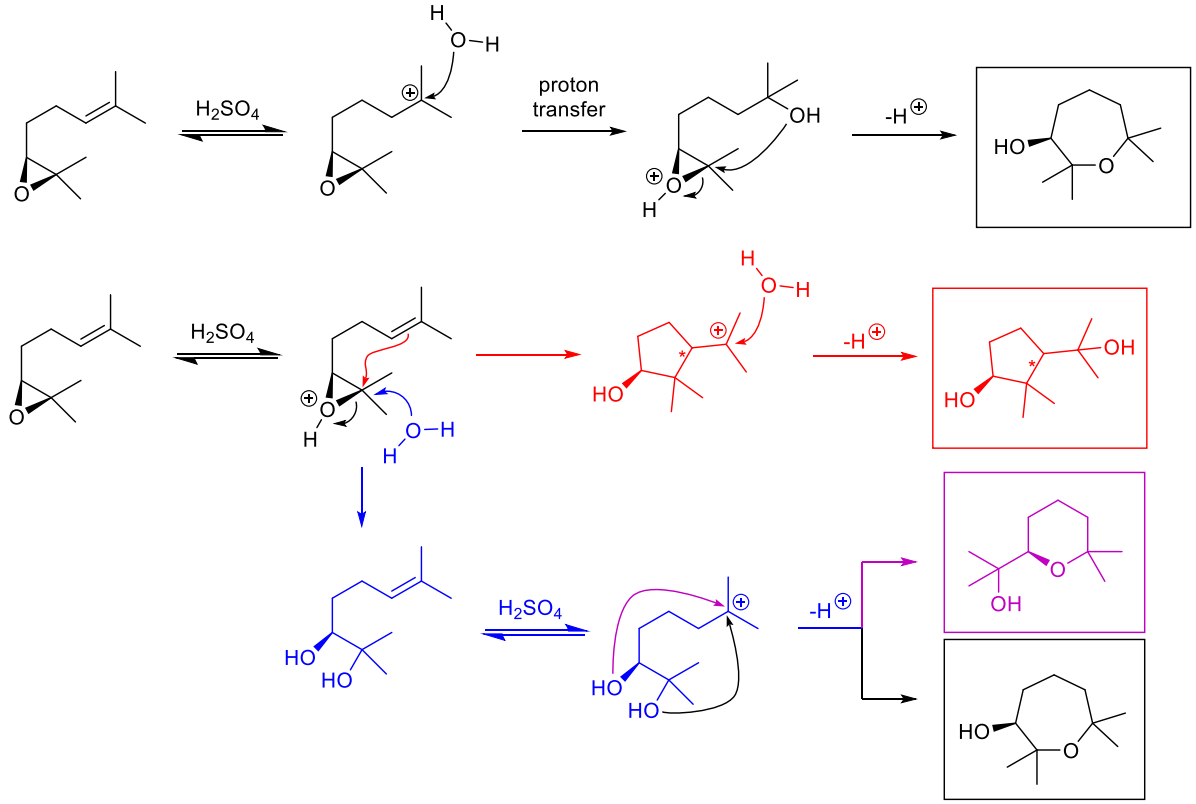
Code	Description	Example
Prevents success: distracting	The student does not use this strategy because it distracts them and they therefore consider it to be detrimental to their success in solving the problem.	“So that one is mainly just because I tend to work things out to the end and then I go back to evaluate whether what I got was reasonable so when I'm working on something I'm not as distracted by what other things could be happening.”
Prevents success: other	The student does not use this strategy because they consider it to be detrimental to their success in solving the problem for another reason, or they state that it is detrimental without stating a specific reason.	“I think the setting goals could be potentially dangerous if it leads you down a wrong path. Especially when approaching certain problems like mechanism or predict-the-products you kind of have to be open-minded until you've at least narrowed it down.”
Issues with timing	The student does not use this strategy because there is not typically enough time for them to use it.	“Yeah, I think just because of the time constraints, I don't normally do that...I don't really have time to list it out.”
Unable to use effectively	The student does not use this strategy because they believe they are unable to use the strategy effectively, often because they do not feel experienced enough to do so.	“I never really predict products because it's really hard for me to visualize what's going to happen.”
Unnecessary: have answer	The student does not use this strategy because they consider it to be unnecessary when they have already found an answer to the problem.	“But like brainstorming other ways to solve it, I feel like in some cases that would kind of be a waste of time or unnecessary since if you're already doing it in your way and that's going to lead to the desired product and you already know that, then you don't really need to brainstorm ways to do it...you're just trying to get to the answer or something.”
Unnecessary: redundant	The student does not use this strategy because they consider it to be unnecessary because they either use a different strategy for the same purpose or use a similar strategy at a different time in the problem.	“After I finish a problem I usually immediately get to the next problem, so that's why I marked "no" on a lot of those, like after the problem checked to see if it made sense, checked to see if you answered the question, I feel like I double-check myself enough times each step if I could actually get to an answer that there's no need to go past that.”
Unnecessary: other	The student does not use this strategy because they consider it to be unnecessary for another reason, or they state that it is unnecessary without stating a specific reason.	“I just don't find it very helpful. I know some people like to make lots of thought maps to understand where the initial reactant could lead them to, but to me, that just seems like a waste of brainpower.”

Appendix S5: Accepted Answers, Mechanisms, and Grading Rubrics for Problems A-D

Accepted Answer(s): Problem A



Mechanism:

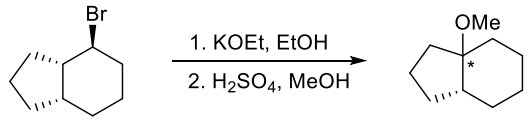


Grading Rubric:

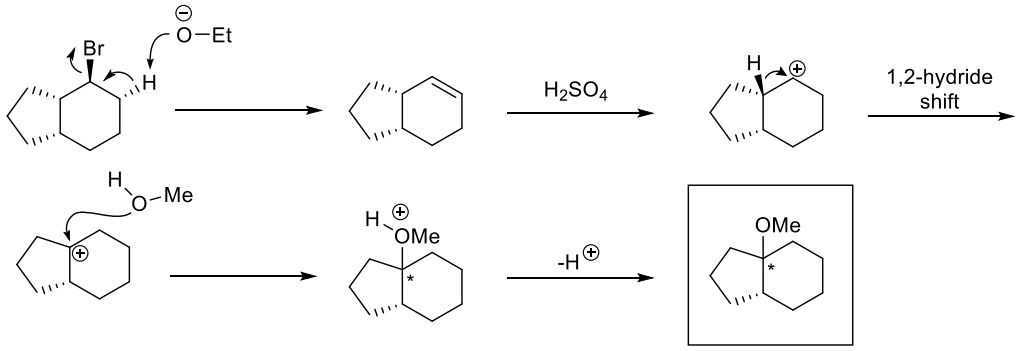
Minimum score: 0 (fully incorrect answer; no partial credit possible)
Maximum score: 4 (fully correct answer)
Partial Credit Options and Point Deductions:

+2 points	Student's product involved a reasonable reaction between the epoxide and the given reagents, but there was no involvement of the alkene
+2 points	Student's product involved a reasonable reaction between the alkene and the given reagents, but there was no involvement of the epoxide
+3 points	Student's product involved reasonable reactions between both the alkene and the epoxide with the given reagents, but no intramolecular cyclization
-0.5 points	Student's product included the result of unreasonable further reactivity
-0.5 points	Stereochemical errors or minor drawing errors are present in the product(s) the student drew. *Note: these errors should not be considered when determining whether an answer qualifies for other partial credit options.*

Accepted Answer(s): Problem B



Mechanism:

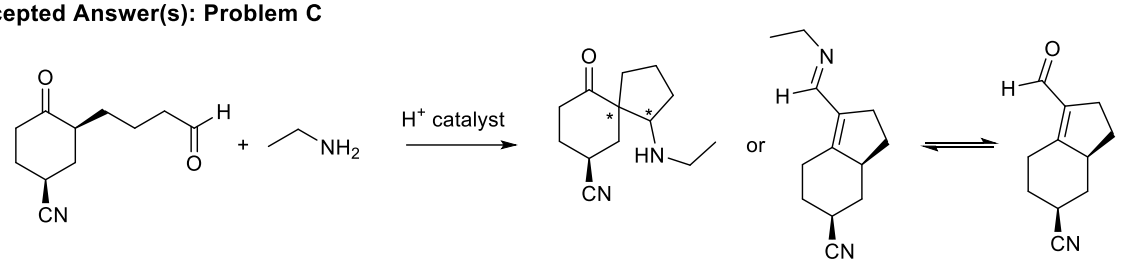


Grading Rubric:

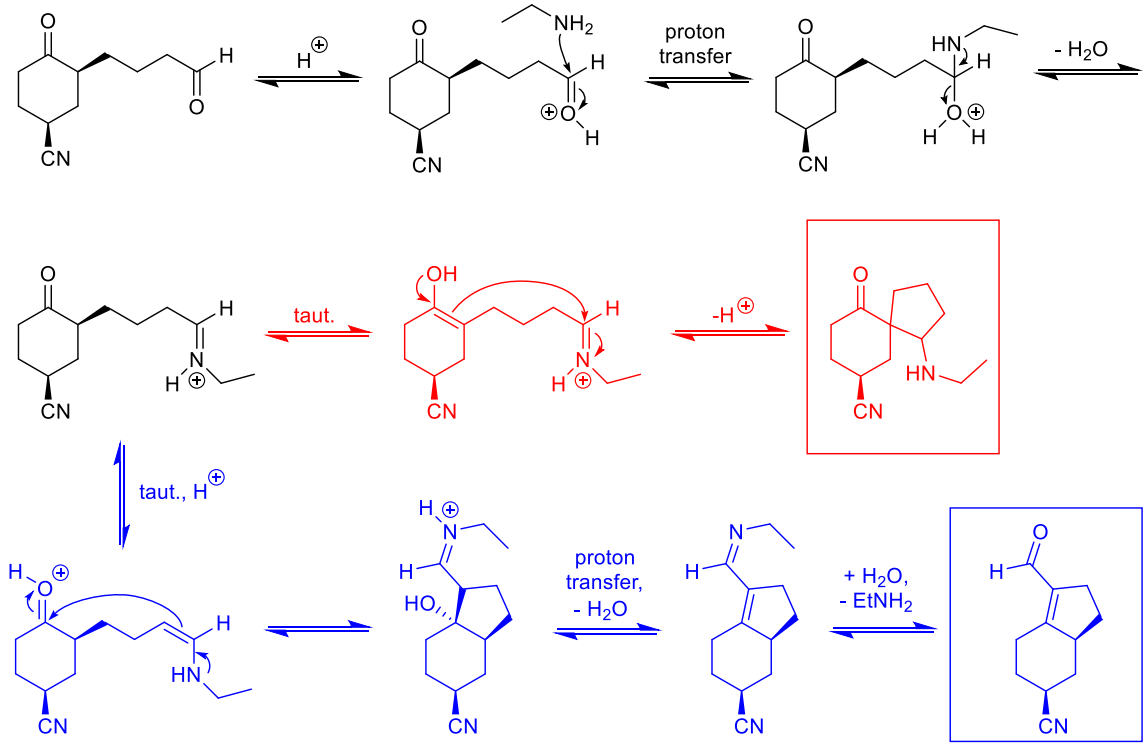
Minimum score: 0 (fully incorrect answer; no partial credit possible)
Maximum score: 4 (fully correct answer)
Partial Credit Options and Point Deductions:

+1 point	Student chose incorrect reaction type (i.e. E1, SN1, or SN2 instead of E2) for step 1, but completed chosen reaction correctly, OR chose correct reaction type (E2) but completed chosen reaction incorrectly
+2 points	Student completed step 1 correctly
+1 point	Based on their answer to step 1, student chose incorrect reaction type for step 2, but completed chosen reaction correctly, OR chose correct reaction type for step 2 but completed chosen reaction incorrectly
+2 points	Student generated correct product in step 2 based on the product they generated in step 1
-0.5 points	Stereochemical errors or minor drawing errors are present in the product(s) the student drew for step 1 and/or step 2. *Note: these errors should not be considered when determining whether an answer qualifies for other partial credit options.*

Accepted Answer(s): Problem C



Mechanism:

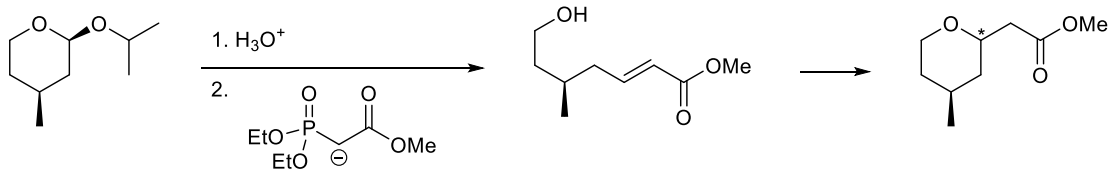


Grading Rubric:

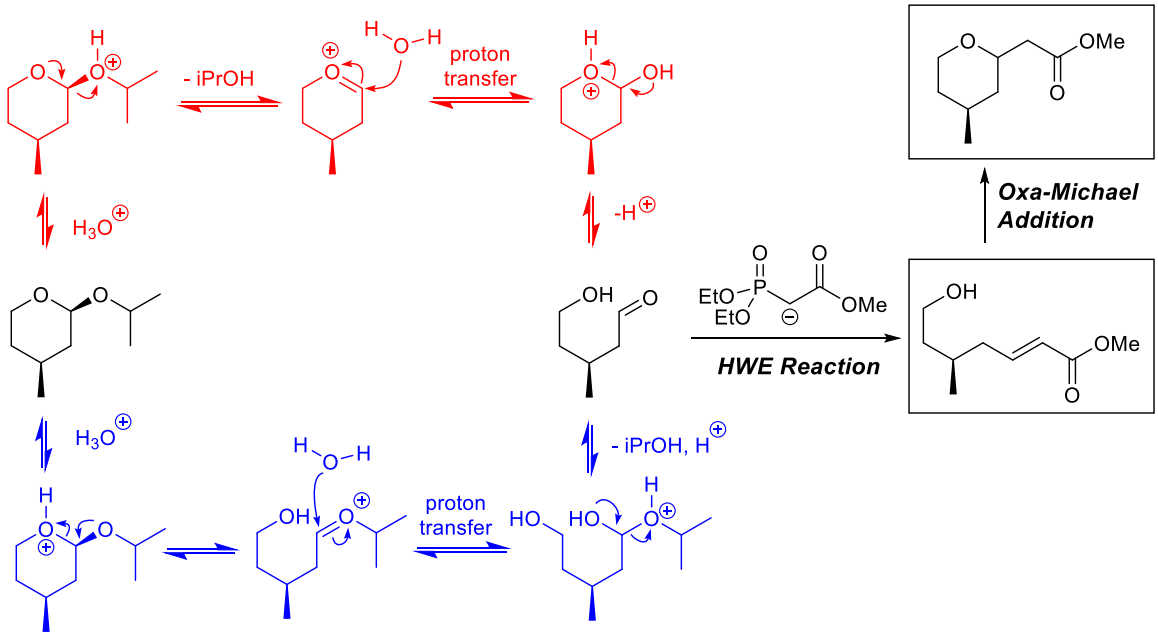
Minimum score: 0 (fully incorrect answer; no partial credit possible)
Maximum score: 4 (fully correct answer)
Partial Credit Options and Point Deductions:

+1 point	Student used ethylamine as a nucleophile to react with one of the carbonyls
+1 point	Student chose correct carbonyl as the electrophile
+1 point	Student generated an imine, iminium ion, or enamine after reacting ethylamine with their chosen carbonyl.
+1 point	Student completed a reasonable intramolecular Mannich reaction or amine-catalyzed aldol reaction after generating an imine, iminium ion, or enamine.
-0.5 points	Student's product included the result of unreasonable further reactivity
-0.5 points	Stereochemical errors or minor drawing errors are present in the product(s) the student drew. *Note: these errors should not be considered when determining whether an answer qualifies for other partial credit options.*

Accepted Answer(s): Problem D



Mechanism: (Note - two possible mechanisms are possible for the hydrolysis of the acetal)



Grading Rubric:

Minimum score: 0 (fully incorrect answer; no partial credit possible)
Maximum score: 4 (fully correct answer)
Partial Credit Options and Point Deductions:

+1 point	Student completed initial steps of the acetal hydrolysis reaction in step 1, but they did not complete the overall acetal hydrolysis transformation correctly
+2 points	Student completed step 1 correctly
+1 point	Student completed first step of the HWE reaction with the product they generated in step 1, but they did not complete the overall HWE transformation correctly
+2 points	Student generated correct product of HWE reaction in step 2 based on the product they generated in step 1
-0.5 points	Stereochemical errors or minor drawing errors are present in the product(s) the student drew. *Note: these errors should not be considered when determining whether an answer qualifies for other partial credit options.*

Appendix S6: Strategies Used By Students During Selected Problem-Solving Cases. Shaded Cells Indicate Strategy Usage

Strategy	Andrew (Less Successful Solution, Lower Metacognition)		Lily (Less Successful Solution, Higher Metacognition)		Ben (More Successful Solution, Lower Metacognition)		Marta (More Successful Solution, Higher Metacognition)	
	Strategy Used?		Strategy Used?		Strategy Used?		Strategy Used?	
	SR [a]	OB [b]	SR	OB	SR	OB	SR	OB
Set Goals	■		■		■		■	
Sort Relevant Info	■	■	■	■	■	■	■	■
Look for Reactions Recognized	■		■	■	■		■	
Reflect Relevant Knowledge	■	■	■	■	■	■	■	■
Relate to Previous Problems	■		■	■	■		■	
Jot Down Ideas								
Make Predictions	■	■	■	■	■		■	■
Brainstorm Multiple Ways			■			■		■
Consider If Plan Reasonable	■		■		■		■	
Consider Another Way			■	■	■		■	■
Monitor Progress Toward Goals			■	■	■		■	■
Monitor Correctness			■	■	■		■	■
Note Uncertainty				■	■		■	■
Periodically Check If Reasonable			■	■			■	■
Consider If Answer Reasonable	■		■	■	■	■	■	
Check If Answered Question	■		■		■		■	
Check For Mistakes		■	■					■
Check If Agreed with Prediction	■		■		■		■	
Summarize Main Takeaways			■					
Consider Changes for Future			■					

[a] Self-reported strategy usage: student selected "yes" when asked on the post-problem survey if they had used this strategy while solving the problem

[b] Observed strategy usage: evidence of this behavior was detected in think-aloud transcript

Appendix S7: Frequencies with which Interview Participants Gave Certain Reasons for Using or Not Using Individual Strategies. Increased Color Saturation Indicates Higher Frequency.

	Builds confidence	Many reactions to consider	Helps them learn/improve	Avoid wasting time/effort	Get started/narrow focus	Keeps them on right track	Keeps them from forgetting	Someone encouraged use	Helps avoid mistakes	Prevents success - other	Prevents success - distracting	Issues with timing	Unable to use effectively	Unnecessary - other	Unnecessary – have answer	Unnecessary - redundant
Set Goals	2	2		1	8	3	1	6	1	4		2	5	3	1	
Sort Relevant Info		1		1	14	1		2				1				
Look for Reactions Recognized	1	4		1	11			2		1						
Reflect Relevant Knowledge			1	1	6	3	1	3	1			1	1	1		
Relate to Previous Problems	1	1	4	1	7			1	1	1	1	1	1	3		
Jot Down Ideas	1	1	2	1	7	1	7	2	3		7	9	4	14	1	
Make Predictions	1			2	2	1		1	2	1	1		11	1	1	
Brainstorm Multiple Ways					2					1	3	8	2	5	4	2
Consider if Plan Reasonable									1		1	1	5			2
Consider Another Way		3		1		1			3	1	4	1	2	1	4	
Monitor Progress Toward Goals				4		4			1			2	3	1		1
Monitor Correctness		1	1	4		4			8		1	1		3		1
Note Uncertainty			5	2	1	4	3		1	1		6	1	2		1
Periodically Check If Reasonable	1			1		6			6	1	3	3	2	3		3
Consider If Answer Reasonable	1								3				2	1	1	
Check If Answered Question			1	1				1	9						1	1
Check For Mistakes	1			1			1	2	18			14	1	2	1	2
Check If Agreed with Prediction			1				1					2	8	2	1	1
Summarize Main Takeaways			12					2	2			10	2	11	5	4
Consider Changes for Future			3						1			4	3	3	5	1