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Workshop Report: "Teaching all first year students how to reason conditionally"

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Abstract

Critical thinking is a crucial attribute faculty strive to foster in students. Especially in our current climate of false narratives and obfuscated data, we want our students to develop sound reasoning skills and avoid errors in logic that frequently appear in political, social, business, and academic arguments. This workshop focused on a particular elementary logical concept known as *the implication, or conditional statement*. In simple terms, this concept is exemplified by the statement "If [A] is true then it must be that [B] is true too". We demonstrated how this type of reasoning is often difficult to understand for most people (Inglis & Simpson, 2004). To solve this problem, we engaged in a discussion about designing activities and content that teaches, both implicitly and explicitly, the logic behind conditional statements. Research has shown that this type of reasoning is challenging when applied to abstract and unfamiliar settings, however, by the end of this workshop, participants took away strategies to teach students these skills in ways all learners can comprehend and be engaged with.

Student's ability to reason logically is important, not only in their academic pursuits, but also and maybe more importantly, in their post-university endeavours as citizens in the world. Obviously we want to make sure that our students can think sharply and correctly about research read and problems encountered, but we do not necessarily explicitly teach these skills in our courses; outside of a few critical thinking courses in philosophy or intro to proofs courses in mathematics, the logical underpinnings of reasoning is something that students are expected to pick up "by osmosis".

At the 2023 AAU Teaching showcase, I organized a workshop entitled "Teaching all first year students how to reason conditionally", in which the primary goal was to convince attendees of the importance of logical reasoning in the classroom - especially conditional sentences of the form "If [A] is true then it must be that [B] is true too", demonstrate our natural propensity to reason incorrectly about these sentences, develop a framework of how to include logical reasoning explicit instruction in your course, and discuss the pros and cons of doing so. Note that conditional sentences are only considered false when they are lying to you; that is, when the if-part is true and the then-part is false. We call such a situation a counterexample to the rule.

Precise abstract logical reasoning does not come naturally to us; consider a study by Inglis and Simpson (2004) in which history students, mathematics students, and mathematics faculty, were given the Wason task; suppose that there are four cards each with a number and letter on either side. You're told the rule that if a card has a B on one side then it has a 9 on the other. You see four cards on a table where you can only observe one face; B,9,A,3. Which of these cards must you check to confirm the rule is being followed? The correct response, choosing the B (to see if there's a 9 on the other side) and the 3 (to see if there's not a B on the other side),

was only chosen by less than 10% of history students, less than 30% of math students, and less than half of math faculty.

However, putting a familiar context to the problem makes the reasoning almost immediate; if someone wishes to check the rule "if you are drinking alcohol you must be of legal age" they would most likely instinctively know that they need to check anyone drinking alcohol to see if they are of legal age (the "B" in the previous example), and anyone not of legal age to make sure they are not drinking alcohol (the "3 in the previous example).

Putting these two ideas together, a natural pedagogical pathway arises; start teaching logical reasoning using a very familiar example, such as the example above, and then pull apart this reasoning into its abstract components. Once students have a grasp on these abstract components formally, this is when we should start applying reasoning about conditional sentences to other situations that the students are not as familiar with. In practice, this third step is the opportunity for the instructor to include examples and situations from their discipline to reason about. Of course this planning of relevant examples will take forethought for the instructor of the course, but it will be worth the effort so that students can apply their new powerful framework of thought and reasoning in the context of the material that they are engaging with in the classroom.

During our group discussion, one point that we returned to frequently was the lack of understanding of conditional reasoning towards their own learning. For example, a professor teaching in music stated that many students reason incorrectly about the statement "if I can play this piece of music then I am a good musician", and think that if they cannot play that piece it indicates that they are not good musicians. Of course, this is not true, and these "gatekeeping" pieces are ones where performers can be excellent musicians and yet not have the particular and singular skill sets to perform a small part of the piece. Similar examples were discussed in the fields of engineering and nursing as well.

To conclude, the overarching sentiment of the discussions were that students do need additional direct instruction in logical reasoning skills, conditional reasoning is a good "sandbox" for students to learn and practice fundamental reasoning in their disciplines, and that these skills can be applied by students to their own sentiments about their own learning in the classroom.

References

Inglis, M., & Simpson, A. (2004, July). Mathematicians and the selection task. Paper presented at the 28th meeting of the International Group for the Psychology of Mathematics Education, Bergen, Norway.