Teaching the Reflection on Argument Quality with a Novel Argument Visualization Tool

Michael H.G. HOFFMANN[1]
Georgia Institute for Technology

Abstract. This contribution introduces the design of a computer-supported argument visualization tool (CSAV), the teaching system ArguLearn. ArguLearn will use scripted user guidance to (a) stimulate reflection on the quality of arguments that students construct and to encourage them to continuously improve the quality of their arguments; (b) to familiarize them with a list of basic quality criteria; and (c) to learn the standard terminology of argument theory.

Keywords. Acceptability, argument quality, argumentation schemes, argumentation vee diagram, ARS criteria, attack, computer-supported argument visualization, critical questions, education, learning, objections, rebuttal, relevance, scripted user guidance, scripts, sufficiency, undercutter, user guidance

1. Introduction

The skills needed to understand the structure of arguments and to create strong and convincing arguments are widely considered a cornerstone of education, as documented, for example in the U.S., in the Common Core State Standards and the Next Generation Science Standards. Both scientific reasoning and the ability to participate competently in civic deliberation presuppose the ability to construct arguments ([1-9]). For this reason, a large number of computer-supported argument visualization (CSAV) technologies has been developed over the past decades (as surveyed by [10] and [11]). These tools, however, focus primarily on students' ability to understand the *structure* of arguments and on practicing their construction. They are not primarily designed to stimulate reflection on the *quality* of the arguments students create in these systems. This is the focus of a novel CSAV tool currently called "ArguLearn" whose design ideas I present here. The primary goal of this presentation is to get feedback on these ideas before the actual design process begins.

As an educational tool, ArguLearn focuses on the following learning goals: To

- stimulate reflection on the quality of arguments that students construct and to encourage them to continuously improve the quality of their arguments
- familiarize students with a list of basic quality criteria that can be used to assess *all* arguments—not only those for which there are argumentation schemes or which commit one of the well-known fallacies

[1] Michael H.G. Hoffmann, School of Public Policy, Georgia Institute of Technology, 685 Cherry Street, N.W., Atlanta, GA 30332-0345, USA; E-mail: m.hoffmann@gatech.edu.

- learn the standard terminology of argument theory and how it is used to communicate issues regarding the structure and quality of arguments and various attack relations.

2. Three approaches to foster reflection on argument quality

When it comes to students' ability to assess the quality of arguments and their willingness to improve these arguments, three types of CSAV approaches can be distinguished ([12]). The first one is to trigger reflection by confronting the user with specific questions that direct attention to critical points. The second approach uses templates that provide a spatial structure to reason about an issue and also include prompts to enter specific items. A third approach is realized in scripted user guidance.

The first approach has been made famous by Doug Walton ([13, 14]). However, a weakness of his approach is that his "critical questions" need to be attached to specific argumentation schemes such as "argument from expert opinion" or "practical reasoning." Since the number of pre-defined argumentation schemes is always limited, whereas the number of non-scheme-following arguments that we can create is unlimited, Walton's critical questions are helpful only for a small fraction of possible arguments students can construct.

An example for the second, template-based CSAV approach to reflection is E. Michael Nussbaum's so-called argumentation vee diagram (AVD; [15]). Nussbaum utilizes also critical questions, but generic ones that are not dependent on certain argument schemes. He and his co-authors designed the argumentation vee diagram to promote critical reflection and "opinion change" by encouraging students "to critically evaluate both sides of controversial issues and 'put the pieces together' in formulating a final conclusion." The basic structure of the vee diagram is a large "V" with the prompt "integrate arguments" at its bottom. This prompt refers to arguments (on the left of the V) and counterarguments (on the right) that students are supposed to formulate with regard to a specific question, prior to the integration. Underneath the prompt "Integrate arguments," the template specifies what is expected by two critical questions: "Which side is stronger, and why?" And: "Is there a compromise or creative solution?" As the authors explain, the first question is meant to foster a "weighing strategy" in which the strength of the arguments on both sides is evaluated, whereas the second question focuses on a "synthesis strategy": the arguer is encouraged to develop "a creative solution that realizes benefits while minimizing disadvantages, or recognizing that the wisdom of an alternative may depend on certain factors ('wise in some circumstances but not others')."

An important limitation of the AVD approach is that it is designed for controversies that have just two sides. As research on "polylogues" has shown, oftentimes we are facing more complex structures ([16, 17]).

Whereas the AVD provides a template to support and promote argument/counter-argument integration in collaborative learning in order to foster "reflection and balanced reasoning," the third approach uses so-called scripts. Originally, the notion of scripts has been introduced to describe standardized routines that reduce cognitive load and effort ([18]). We are all familiar with what it means to dine in a restaurant. There is a sequence of expected events that begins with a hungry customer entering the restaurant, ordering, eating, paying, and then ends with the customer exiting. This script has several components: props including tables, menus, food, and money, as well as roles including customers, servers, chefs, and a cashier. In the educational literature, the notion of

"scripts" has become an important tool in a *normative*, not descriptive sense, to outline procedures and strategies a learner *should* become familiar with to achieve certain learning goals. Today, scripts in this normative sense are crucial for the design of computer-supported learning systems ([19, 20]). In these systems, scripts are usually implemented in the form of user guidance. The scripts prescribe certain sequences of activities which are deemed cognitively important for learning.

An example for a CSAV tool that is designed to promote reflection on the quality of arguments by means of scripted user guidance is the AGORA software ([12, 21]). Any construction of an argument starts here with the prompt "What is the main claim of your argument?" The normativity of the script realized in this system becomes clear in the fact that it is, thus, impossible to begin the process with the formulations of reasons, for example. Only after the entry of a claim is the user prompted to provide a reason for this claim.

AGORA attempts to stimulate reflection on the quality of arguments by a design feature that is unique among currently available CSAV tools. It offers only logically valid argument schemes that students are prompted to select in the process of argument construction so that each of their arguments is, at the end, visualized in logical form. The reason for this design decision is the consideration that it should be cognitively beneficial to confront the learner with the strongest form of sufficiency of reasons: logical validity. In a logically valid argument the reasons need to be formulated so that it is impossible that all the reasons are true but the conclusion false. This requires that the inferential link between reason and conclusion needs to be explicitly stated. If I claim "Paul is responsible for what he did" and provide the reason "Paul is a rational human being," then this argument is logically valid only if it includes an additional premise such as "If Paul is a rational human being, then Paul is responsible for what he did." AGORA automatically creates such a premise after the user selects an appropriate scheme—in this case modus ponens. By asking the user whether they would accept this additional premise as "true or acceptable without exceptions, in all circumstances," the user is supposed to reflect on the question whether their argument satisfies the strongest version of sufficiency.

3. The ArguLearn approach to stimulate reflection on argument quality

The design of the ArguLearn CSAV tool builds on that of AGORA but it uses more criteria, and its scripted user guidance exposes the user in greater detail to how these criteria should be used. Moreover, the quality assessment will be *optional* to cope with the problem of "overscripting" ([22]). Since user guidance can feel coercive, it is important to find the right balance between "the two poles of coerciveness and freedom" in scripting ([23]). After the completion of each argument, the user is invited to perform a "Quality check." If they choose to do so, they would see a screen like the one depicted in Figure 1.

The quality criteria with which the user is confronted here include the well-known "ARS criteria" formulated by Ralph Johnson and Anthony Blair (acceptability, relevance, and sufficiency [24]), but also criteria that CSAV tool creators such as Tim van Gelder and Simon Cullen identified as relevant in tutorials for their Rationale and MindMup tool (for more on these criteria, see [25]). The list of the six quality criteria that is indicated with the bullet points in the yellow box in Figure 1 and the procedure of how

they should be applied has been determined in a recent, NSF supported research project by a method called "Task Analysis by Problem Solving" (TAPS, [26]).

To explain what the concepts mean by which these criteria are introduced and how to use them, users can find additional explanations when they move over particular criteria (see Figures 2 and 3 for examples).

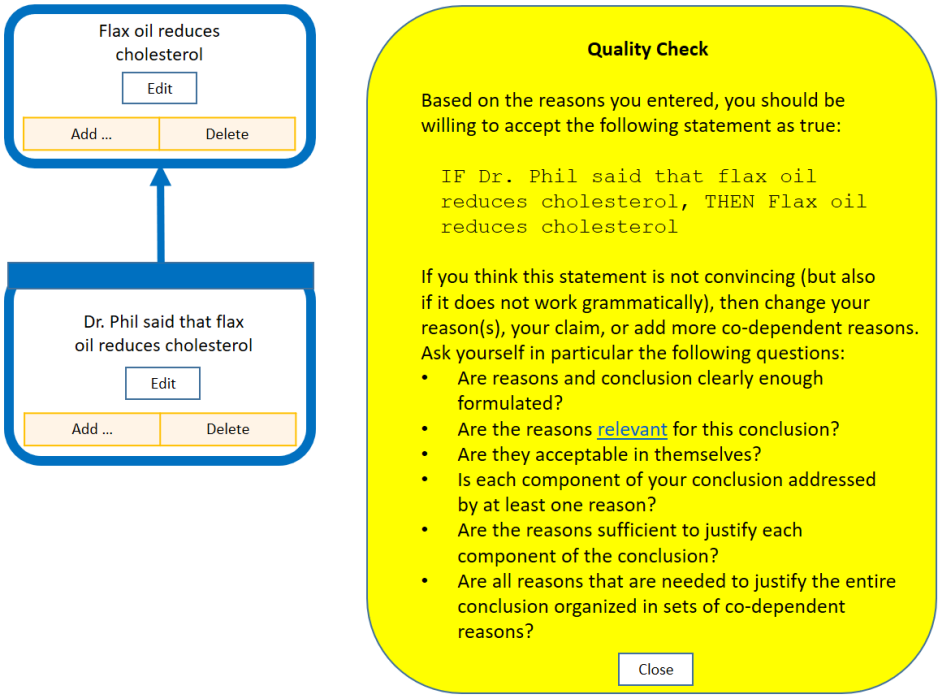

Figure 1. The statement in the yellow box is functionally equivalent to the additional premise created in AGORA. However, whereas AGORA integrates this statement automatically in the argument—transforming it, thus, into a logically valid modus ponens—ArguLearn uses it only if a user wants to check the quality of an argument. Moreover, whereas the AGORA user is prompted to ask "Is this enabler grammatically correct? Is it true or acceptable without exception, in all circumstances?" the questions in ArguLearn focus more specifically on the six quality criteria which are addressed by the bullet points at the end. Moving the mouse over each criterion will open a tooltip with additional explanations. For examples see Figures 2 and 3.

To familiarize students with various options to attack an argument, ArguLearn will allow objections against particular reasons, undercutters, and rebuttals. For example, if a user selects "Visualize or attack the inferential link" of a given argument, this inferential link will first be visualized in form of the additional premise that makes a modus ponens argument logically valid. Attacking this premise, the user can then add an "objection (undercutter)" as depicted in Figure 4. Selecting, by contrast, an "objection (rebuttal)" against the conclusion of an argument will lead to a screen like the one in Figure 5.

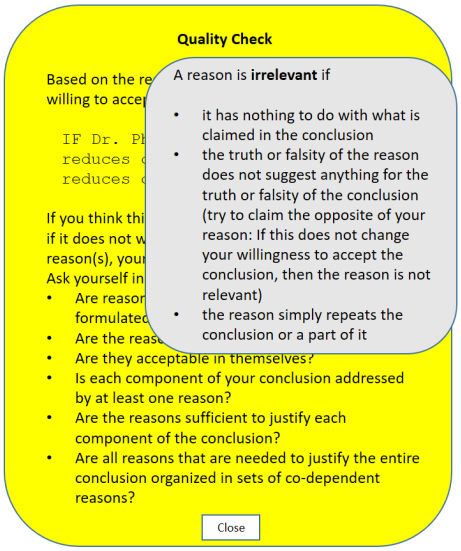

Figure 2. Relevance explained.

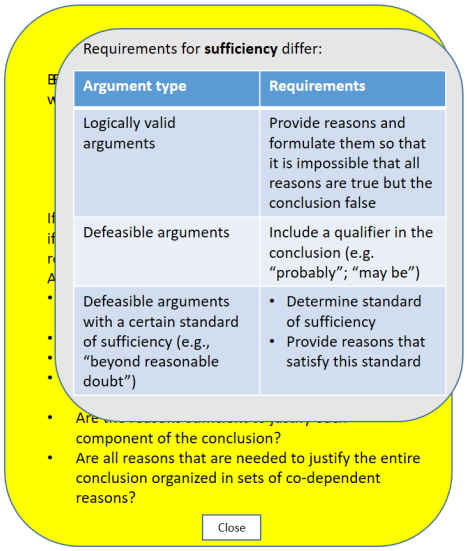

Figure 3. Sufficiency explained.

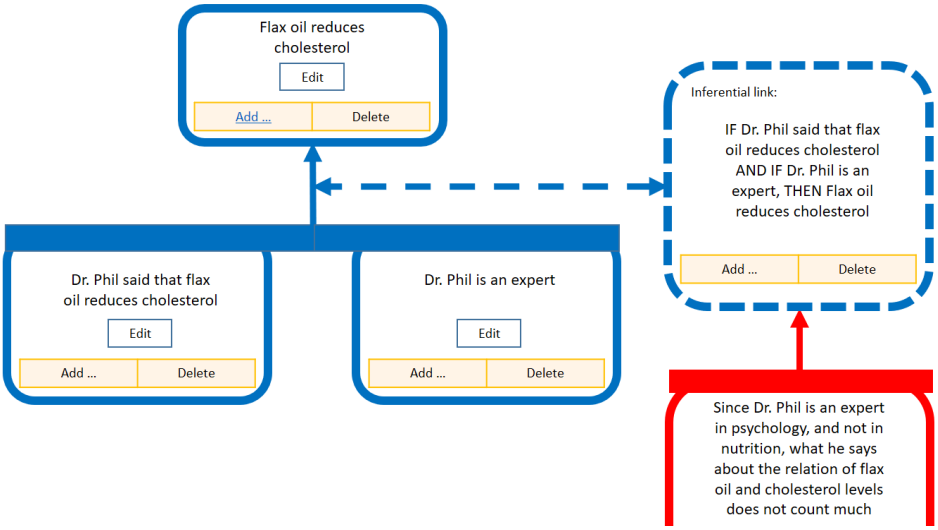

Figure 4. Just as in AGORA, an argument's inferential link (in the box with the dotted line) will be expressed in form of that premise which would transform the argument into a logically valid modus ponens. The undercutter in the red box attacks the argument's inferential link.

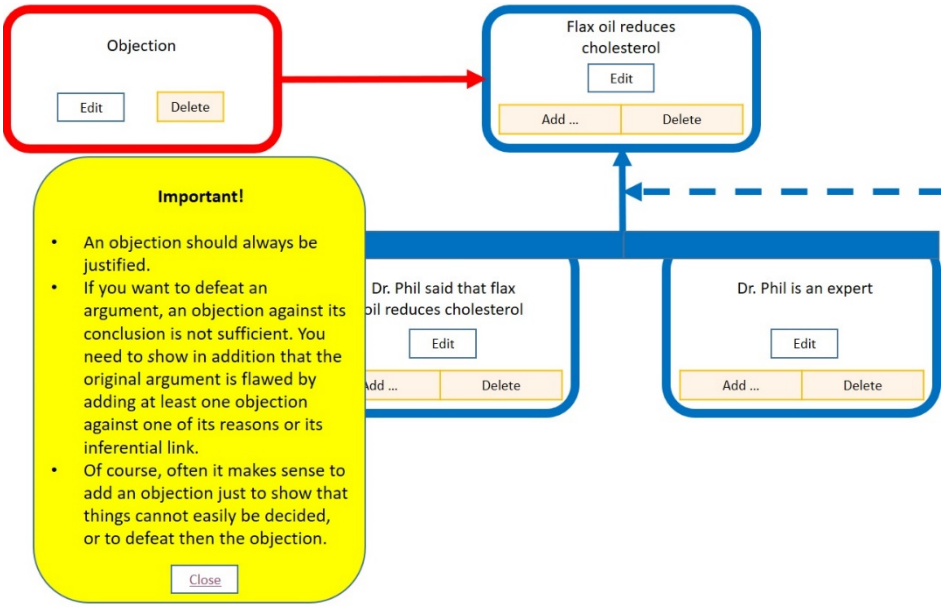

Figure 5. Instructions on how to work with rebuttals.

In addition to scripts that guide learners through the processes of quality assessment and adding objections, ArguLearn will also prompt users to determine "the strength" of objections by one of three options: "Defeat" (requires a justification); "Enter value" (allows entering a value between 3 and -3, where "Positive values describe the strength of the objection over the original argument, and negative values the opposite"); and "I don't know."

4. Conclusion

The ability to create clearly structured arguments of high quality is, and should be, one of the most important goals in education. Computer-supported argument visualization tools have been designed to support corresponding efforts. However, existing tools focus primarily on the structure of arguments without offering much that would motivate users to reflect more consciously and critically on the *quality* of the arguments they construct.

An essential problem regarding the quality of arguments is that there is no agreement in the argumentation community on how such quality should be determined. While the ARS criteria (acceptability, relevance, and sufficiency) suggested by Johnson and Blair in the seventies ([24]) are widely accepted as a possible core of argument assessment, an analysis of thousands of argument maps that students created for a wide variety of projects over the years showed me that there are more criteria for argument quality that should be taught in a systematic way. For example, the observation that students sometimes put entire arguments in the conclusion box of an argument map led to the formulation of a quality criterion that focuses on how to formulate reasons and the conclusion. Or: Students often formulate conclusions with multiple components, but the reasons they provide justify just one of these components ("AI technology should

perform tasks to assist employees in warehouses, but it should not perform tasks autonomously"). Another criterion that turned out to be important is that students often do not understand the significance of the distinction between co-dependent reasons that are all needed to justify all elements of a conclusion and sets of reasons that can justify the conclusion independently from each other.

Building on the literature on educational scripts, the novel CSAV tool ArguLearn that this contribution envisions would provide scripted user guidance that focuses on a systemic way to familiarize students with a set of six quality criteria (indicated in the bullet points of Figure 1 above). The main idea is to design user guidance so that students are motivated to reflect more thoroughly on the quality of arguments they create, and to show them how this can be done. Moreover, the ArguLearn approach aims at teaching students some core concepts of argument theory, including the distinction of various ways to attack arguments.

Next steps of this project include the creation of such an ArguLearn tool and its evaluation in educational settings.

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