Dr. Trevor M. Cickovski
Assistant Teaching Professor of Computer Science
Florida International University

Philosophy of Teaching

Completed: July 2020

In its simplest terms, to "profess" means to "speak truth", and ones' teaching philosophy will therefore be inevitably based on one's perception of reality. This particular one is built around a **reality of life as an infinitely evolving picture, composed of a puzzle consisting of multiple interdependent pieces that when fit together complete this picture**. Some of these pieces are the course material professed by the teacher. Other pieces include the teacher themselves, and each student. Therefore through no choice of their own, teacher and student alike are part of and contribute to this dynamic, not static, picture. These contributions can be made in ways that *advance* (call them 'positive') or *restrict* (call them 'negative').

The next question becomes, how can we contribute positively? Thinking in terms of collective advancement requires more encompassing goals than simply reaching your own potential. To be positive, contributions must be accurately seen in the context of addressing the needs of the larger picture. "Big picture needs" covers an infinite, continuous, and dynamic area and cannot ever be fully mastered. Nevertheless, we can learn through observation. A stray cat goes from constant flight-or-fight mode to a friend who greets you every morning once taken into a home and provided proper care. Crops produce abundant fruit once provided with proper nourishment. Appropriate care is essential to yielding optimal performance on a computer.

Each of these involve accounting for the needs of something (living or non-living), then taking action to address these needs. This dovetails into the ideas of C. S. Lewis, who described the ultimate form of love, **agape** (from the Greek for "charity"), as involving "**love in ACTION**". With this Lewis moves love beyond an overused, surface-level cliché, from something we ***say*** to something we ***do***. Merged with the above perception, agape can be seen as actively contributing positively to this picture. And it is to be sure a monumental task that no one can ever perform perfectly because of some innate selfishness. But imperfection never implies impossibility, as discussed by Carol Dweck in *The Growth Mindset*. The goal needs never be perfection, but improvement.

Agape is therefore the goal of this teaching philosophy, built around an idea that upon completing their education students should be actively contributing positively to the evolving picture of society. Although agape is the ultimate goal, approaching it requires building solid foundations. The final page of this document shows this philosophy visually as a pyramid, with agape at the top but supported by three lower layers that each involve one key question to answer and understand:

Layer 1. Knowledge. Key question: *What are the pieces of the puzzle?*
Layer 2. Vision. Key question: *How do these pieces fit together to complete the picture?*
Layer 3. Perception. Key question: *How is this picture changing?*
Layer 4. Agape. Key question: *How can I contribute to this changing picture?*

Each layer builds upon the one beneath. Knowledge provides pieces for vision. Vision provides a picture for perception. Perception provides a changing picture for agape. The pyramid also shows specific tools that can be used to cultivate each layer, now discussed in more depth. To re-emphasize, it is fundamental to keep in mind at every stage that <u>**teacher and student as well as course content are pieces of this puzzle**</u>.

KNOWLEDGE. Knowledge has historically been at the core of academia, and is inherently infinite. It represents an understanding of facts, and can be increased at highly efficient rates today as information becomes available at our fingertips. Yet teaching also requires knowledge that cannot be found online, and that is knowledge about ourselves and our students (as mentioned, also pieces of the puzzle). In summary, then, **the "knowledge" component of teaching involves not just <u>what</u> you are teaching, but also <u>to whom</u>**. Achieving this in today's world makes each the following important:

1. <u>***Online Textbook/Lecture***</u>. Textbook and lectures can be outstanding tools for developing knowledge, but must be implemented properly. Reading and absorbing paragraphs of knowledge from a textbook or hour-long lecture can be a challenging task. Online textbooks offer interactive sample problems solvable by students while doing the reading. With online lectures students can listen and learn at their own pace, ameliorating previous challenges with delivering a single lecture to students with wide arrays of "ideal learning paces". "Online" is the common ground and though its mere mention can make many educators shudder, each of these were developed in response to the reality of how the typical student's mind has been trained from childhood, as well as how they will likely need to learn in the future. Writing this during the time of Covid-19 quarantine only reinforces this need.

2. <u>***Source Legitimacy***</u>. Source legitimacy is one key component put in jeopardy by online tools, and teachers must make students aware of it. While a lecture comes from a qualified professor, and a textbook from a qualified author, an online tool very often comes from a question mark. Students must therefore be trained by teachers to evaluate online sources as legitimate or not, by learning to research the author along with their track record, institutions, etc.

3. <u>***Know Students***</u>. With students and faculty sharing roles as pieces of this picture, knowledge must also involve the teacher knowing their students and vice-versa. It also involves the faculty member and students knowing themselves. This can be achieved through student surveys that are not required. Student should not be forced to disclose any information that leaves them uncomfortable. Teachers should also complete this same survey and disclose answers to the students, after distributing the survey but before students complete it. Two birds can be killed with one stone by providing questions on this survey that force self-reflection.

VISION. In the film *Mr. Holland's Opus*, when a former musician is struggling in his teaching career, he is given the following advice from his principal: "A teacher has two jobs. Fill young minds with knowledge, yes, but more important -- give those minds a compass so that knowledge does not go to waste." This compass is the vision. If knowledge involves puzzle pieces, vision involves completing the puzzle. The pyramid structure is upheld; just like you cannot complete a puzzle without the pieces, knowledge is a building block for correct vision. But without vision, the pieces remain disconnected. Leaping from knowledge to vision requires a learning environment that involves **taking knowledge of <u>self</u>, <u>others</u> and <u>course material</u> and integrating them together in a way that makes sense**. Vision can be cultivated in the classroom through:

1. ***<u>Interactive Projects (IPs).</u>*** An Interactive Project (IP) is a team project with the following requirements:
1. They change every semester.
2. They involve a solution not achievable solely by reading the textbook or searching online.
3. They involve some creative or "out-of-the-box" application of the material.
4. They apply course material to a real-world situation.

Returning to the example of the hardware course, for a data representation unit, an IP could involve estimating speed and memory consumption of two C programs based on variable datatypes, running tests to determine the correctness of the hypothesis, and/or reasons behind its incorrectness. Executing such an IP on a floating-point optimized architecture would throw an interesting curveball into the mix.

Consider how such an IP builds on knowledge to achieve vision. Textbook and lecture provide students *knowledge* of how to convert any integer or floating-point value to binary. In this IP students can *see* how hardware impacts decisions they should be making as programmers, *connecting* two puzzle pieces that previously may have remained disconnected. By viewing these effects first-hand, course material and its practicality come alive. Further, the team environment integrates a student (one 'piece') with other students (additional 'pieces'), helping them to develop important skills of working with their environment to create positive change, and ideally also developing clearer pictures of their own unique roles in this environment.

2. ***<u>Teamwork</u>***. The purpose of teamwork is to create an experiential learning environment that facilitates the mutual exchange of ideas. Several players encompass a learning environment, including teacher and students. None of them own all knowledge of the field; each of them bring unique sets of capabilities and experiences. This holds beautiful implications, specifically they each player has a specific role in the larger picture only they can complete. Teachers should be aware of this reality and foster it in their students. Although these roles may be unclear at present, they demand mutual respect between all individuals in the classroom. This also implies that **<u>maximizing learning at the macroscale requires free exchange of ideas between individuals at the microscale</u>**. Lecture offers a single one-way channel for idea exchange (teacher to student). Multiple channels become possible by having a team environment for IPs. The optimal number of channels for a particular IP involves many factors, including course size, level of difficulty, etc. The teacher must evaluate, monitor and maintain this as best possible every semester. Additionally, no channel should ever be one-way, including teacher-to-student. Efforts to integrate even the most reserved contributors must always be made. Additionally, the student-to-teacher channel must always be kept open. In computer science this is equally vital for teacher development, as younger generations almost always bring more experience using advanced technology from an earlier age. A teacher must never be reluctant to even incorporate new concepts from students in future coursework. In this sense, the purest learning environment is a mutual one between teacher and students.

3. ***Cross-Course Connection (CCC).*** Each course has prerequisites, therefore by definition teachers arrives with some knowledge of student background. Vision involves learning how pieces of knowledge fit together, and therefore teachers have a responsibility to connect material ('pieces') from their course to other courses (establishing cross-course connection, or CCC) or even past experiences (other 'pieces'). As a hardware professor one can integrate questions such as: Why when you download a program for Intel on PowerPC does it not do anything discernible? Why is an operation often slowest the first time you run it? These are past experiences that can now make sense, and the connections to hardware now become apparent. Other mysteries to unravel can involve introductory programming questions such as why array indexing starts from zero, or why it is not appropriate to blindly use double-precision for all real values.

PERCEPTION. Knowledge and vision complete a static, current picture. Perception then asks, "How does this picture progress?" At this level we incorporate the *dynamic* nature of the picture. Referencing the pyramid, vision is a building block for perception since understanding how a picture changes is fruitless without understanding the picture. **Perception is what allows an individual to move with a changing picture, as opposed to becoming 'stuck'**. Several strategies are helpful:

1. ***Research***. Teaching and research are intimately intertwined. The role of research in teaching carries a controversial tone in modern academia, particularly as positions become polarized into "tenure-track" ("research faculty") and "non-tenure-track" ("teaching faculty"). Accepted definitions of research run counter to this mutual exclusion. One source defines "research" as "the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions." By this argument, particularly in the context of understanding a dynamic picture, **research improves teaching ability, and better researchers will make better teachers** *provided the caveat that all other factors are equal*. In fact, research encapsulates the entire pyramid thus far – "materials and sources" are knowledge, a "systematic investigation" involves vision and "establishing facts and reaching new conclusions" involves perception. Research maintains a teacher's active participation in this changing picture, enabling them to understand its continued evolution and how even their course content fits. They can then communicate these ideas to students, both in the classroom and through REU opportunities.

2. ***Incremental IPs***. Although IPs should never repeat themselves between semesters, they can be "incremental" in nature. An "incremental" IP involves maintaining some centralized repository that contains a "current state", which a future IP extends to create an improved "next state". A most basic example would be a CPU that is extended to support one more assembly instruction every semester. Each semester at least one student submission should be committed to the repository and encapsulated into the "next state", and this process can infinitely repeat. Desiring to have your submission as a permanent part of this repository and future course offerings can serve as an outstanding motivator. Incremental IPs make perception come alive through first-hand observation, training student minds to think about the current state of a system and how it can be improved.

3. ***In-Context Teaching***. To help students "soar like eagles" as opposed to "wandering like kiwi birds" (cf. Denise Clelan's "Wisdom on Wings"), material must carry context. Teaching perception involves pursuing topics within a context of relevance, and how they positively advance a field. Students must understand why course topics and objectives are incorporated and therefore seen as necessary for future success. In computing specifically, such learning can take the form of understanding how course material addresses the needs of different populations. Students should understand tradeoffs in modern computing solutions; including speed, memory, power and cost. Projects and examinations should involve completing optimal, not just working solutions. Such a mentality creates a playing field where motivation extends beyond achieving high grades and ventures into a real desire to contribute to the field. Such motivation may even naturally lead to higher grades. Repetition leads to registration, therefore a teacher adopting this mentality will have students more likely to follow, and be better prepared them to take action on this motivation (the tip of the pyramid, agape).

AGAPE. Knowledge, vision, and perception establish a firm foundation that builds understanding of the current picture and how it is changing. The final step then becomes to **act**. Action is the most fundamental concept to Lewis' ultimate form of love, agape.

1. ***Active Learning***. At this level students must understand how to put into practice what they have learned, pointing to an emphasis on active learning above passive listening. The benefits of "learning by doing" are now well-established in education, with active learning now widely accepted as a successful strategy. In the context of agape **active learning is a perfect fit because of its core concept of "action"**.

2. ***Flipped Classroom with Learning Assistants (LAs)***. If active learning provides such benefit over passive listening, class time should be budgeted accordingly. Lecture has a place as it is important for building knowledge bases, however it can simply occupy a smaller percentage of course time (say 20-25%). The rest can be allocated to a flipped classroom, and IPs fit perfectly into such a setting. The teacher provides guidance to each individual team, obtaining an idea of unique dynamics, facilitating communication and creativity, etc. Undergraduate learning assistants (LAs) should be incorporated into this setting, preferably those who have taken the course before. LAs bring something new to the learning environment, an individual near in age to the students with likely similar life experiences, to whom students most often feel more comfortable opening up than the teacher. The decision as to which students to incorporate as LAs should therefore never be taken lightly, nor should it necessarily be the students with the best grades. The LA should be a self-motivated, passionate individual with a welcoming and non-judgmental personality, around whom students feel relaxed and have no reservations expressing concerns. Weekly LA meetings with the teacher then become essential for establishing how best to address individual student needs.

3. ***Student-Choice IPs***. The student-choice IP is a component that ideally should take place at the end of a "course sequence", where a "course sequence" is a pipeline of courses taken in order often to complete a requirement (for example, a hardware "sequence" may consist of logic design and computer architecture). Returning to the foundations, acting on a desire to make positive contributions to society forms the essence of agape. The idea of the student-choice IP is

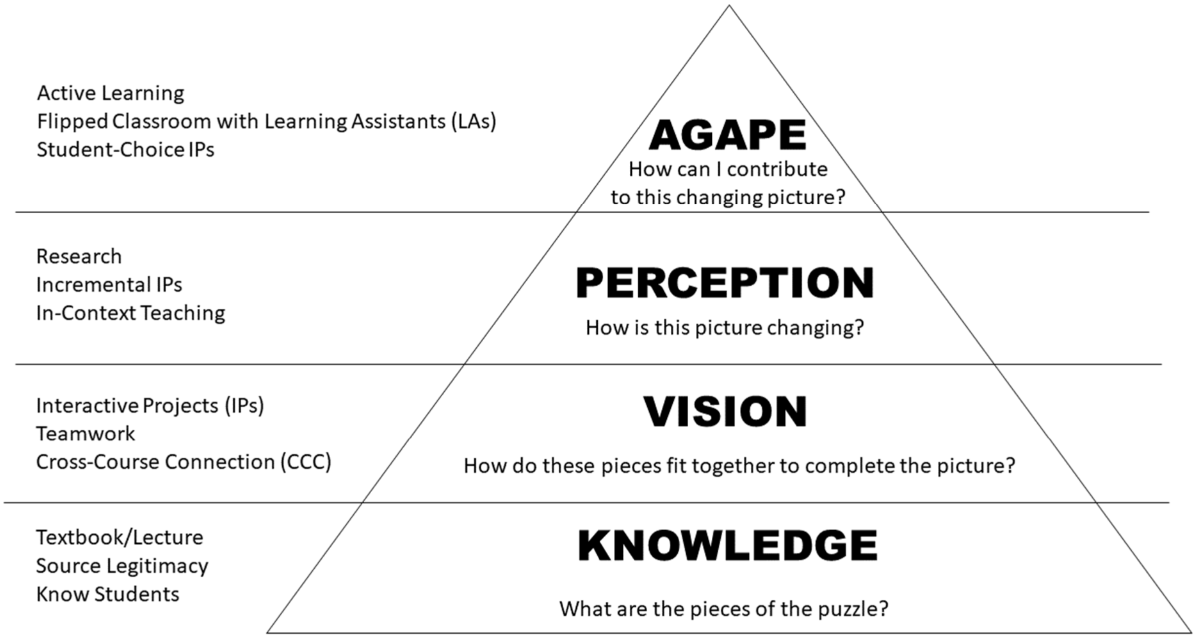
to give students a chance to put agape into practice, so that students reach the "top of the pyramid" upon "graduation" from a course sequence. The "student-choice" IP is therefore open-ended, with a requirement that it must involve some new contribution to the field. In the modern age of open-source software and academic licenses to research papers, the opportunity for this has never been greater in computer science. It is a rewarding opportunity for students that can be maintained in a public repository for many years, help build a resume, etc. The teacher must help make the judgement as far as novelty and practicality of the idea, through an approval process with students. Coupling this to a flipped classroom enables the teacher to work with students in developing vital skills such as how to survey the literature to determine the current state of their area of interest, determine a current deficiency and how it can best be addressed, develop a solution to completely or partially address the deficiency, and evaluate its success.

Student Assessment

In this model three very broad tools become useful for student assessment; with some ability to maneuver within each area. "Exams" may encompass everything from pop quizzes to final examinations, under the assumption they are individual, closed-book and closed-internet. If a "grade" is to be interpreted as an estimate of qualification level in course material (probably a realistic assessment of how institutions view them), examinations become the only way to evaluate this at an individual level with any reasonable degree of accuracy. Therefore they should encapsulate the largest percentage of a course grade, essentially requiring a passing grade to get through the class. If most students require a "C" or better, a percentage of 65-70% is convenient as failing to score at least a "D" on examinations makes it very difficult to achieve a "C" overall, independent of the remaining percentage. Since examinations encapsulate such a large percentage, they should involve questions that test all four levels of the pyramid (see the table below)

IPs are conducted in an environment that runs counter to examinations, as these are team, open-book and open-internet. Since they will involve the three upper levels of the pyramid, they should compose a large part of the remaining percentage. A percentage of 25-30% for IPs leaves what can be viewed as a "free" 5-10% for textbook homework, which mainly builds knowledge. Online solutions to textbook problems are now widespread. Artificial intelligences are now available that can provide reasonable answers when fed sample homework questions, rendering even plagiarism detection inapplicable in that situation. It can therefore never be assumed that homework performed outside of class is completed solely by an individual. Homework should therefore be considered as "training exercises" for examinations, which as mentioned are necessary to pass the class. Students then are given the freedom to train as they choose, rewarded with the small remaining percentage if they complete it.

SUPPLEMENTARY MATRIAL: TEACHING PYRAMID



SUPPLEMENTARY TABLE: ASSESSMENT

Assessment Tool	Knowledge	Vision	Perception	Agape	Percentage
Examinations	x	x	x	x	65-70%
IPs		x	x	x	25-30%
Homework	x				5-10%