Cognitive Science Teaching Strategies and Literacy-Targeted Economics Complementarities

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Instructors designing an introductory course have decisions to make regarding instruction that fall into two broad categories -- what to teach, and how to teach it, or content and pedagogy. In this paper we propose a literacy targeted course for content. On the pedagogy side, we propose strategies that leverage research-based methods from cognitive science. We believe this combination provides students with the optimal combination of relevant content delivered using engaging pedagogy that ensures that learning is deep and durable.

Literature Review

The call to provide a more focused, literacy targeted has a long history. A 1950 report to the American Economic Association recommended: “The number of objectives and the content of the elementary course should be reduced” (Hewitt, et al., p. 56). In 1963 George Stigler complained: “The watered down encyclopedia which constitutes the present course in beginning college economics does not teach the student how to think on economic questions.... The student will memorize a few facts, diagrams, and policy recommendations and ten years later will be as untutored in economics as the day he entered the class” (p. 657). In all likelihood, the knowledge will be forgotten in less time than ten years. In 1998, Robert Frank suggested that the “best way to teach introductory microeconomics is to expose students to repeated applications of a short list of the core ideas of the discipline” (p. 13). The obvious question, which Frank also posed, is whose list to use.

Hansen, Salemi, and Siegfried (2002) propose a two course approach, a standard principles course with the usual number of concepts and models which is intended to equip students for further work in economics and related fields, and a one-term course that will improve economic literacy for students who are likely to only take a single one-term course in economics, (the “one and done” group). For the literacy targeted course, they suggest using the 20 standards found in the Voluntary National Content Standards in Economics (Council on Economic Education) as the building blocks, and suggest that, “what matters is how well students can apply their learning not only now, but later, long after they complete their schooling” (.p. 466). For the literacy targeted course, they suggest dropping some of the traditional content: cost curves,

[1] The views expressed here are not the views of the Federal Reserve Bank of St. Louis, the Federal Reserve Board, or the Federal Reserve System.

aggregate supply and demand, and extensive market structure comparisons; and they suggest limiting coverage of elasticity calculations, national income accounting, and multipliers.

The concern of some is that students who take the literacy targeted course, and then decide to major in economics, might be at a disadvantage in upper level courses because they may have missed key content they need later in the course sequence. To assess this concern, Gilleskie and Salemi (2012) compared how students who had taken a literacy targeted course with students who had taken the standard course when both groups took intermediate level courses. They found that students who completed the literacy-targeted principles course earned grades as high as those who completed a traditional course. Gilleski and Salemi end their paper warning that the data are from a single university, and recommend others attempt to replicate their findings. Benjamin, Cohen and Hamilton (2020) took up the challenge, using a data set of 13,000 students over 11 years at the University of Toronto. Their findings supported Gilleskie and Salami – students who took the literacy targeted courses did just as well in intermediate theory courses as their peers in traditional principles courses. They argue that if the literacy targeted approach makes the 80 percent of students who never take another economics better off, while doing no harm to those who major, the literacy targeted course should be offered as a Parerto improving alternative to standard principles.

When it comes to pedagogy in economics classrooms, Goffe and Kauper (2014) report, when surveyed, instructors reported that they allocate 61 percent of class time to lecture, 21 percent to leading classroom discussion, and 18 percent to implementing methods such as experiments, group activities, peer instruction, and clickers. Sherian and Smith (2020) show that instructors underestimate the time they spend lecturing, suggesting the number is about 89 percent of class time. And while lecture dominates, a majority of instructors realize its shortcomings. Specifically, when asked about how students learn, only 33 percent of instructors thought students learn best from lecture, while 28 percent acknowledged that students do not learn best from lecture, they viewed lecture as a “cost-effective” way to deliver content, and 39 percent acknowledged students do not learn best from lecture and were open to alternatives. Surely, covering the large number of concepts and models in the standard one-semester course imposes a burdensome time constraint on instructors. In their description of a literacy targeted course, Hansen, Salemi, and Siegfried (2002) suggest allocating the time that would be spent covering complex content in the standard course, to improved pedagogical practices such as a focus on issues, policies, and puzzles, cooperative learning, and opportunities to practice. In this way, a literacy targeted economics course provides a pareto optimal approach to content, and covering less content gives instructors more time to pursue methods that might have better learning outcomes but may be perceived as less “cost-effective” than lecture. Boyle and Goffe (2018) implemented teaching practices common in STEM instruction, but uncommon in economics classrooms, and showed promising results. These innovations go beyond “flipping” or “active learning” and use innovations are often referred to as “research-based” or “evidence-based.” In the rest of this paper we will discuss strategies for implementing research-based instructional practices in the context of a literacy targeted economics course.

Content -- Using Simple Economic Models Repeatedly

Introductory and principles level textbooks often begin with a set of key concepts that lay the foundation of thinking for later content. Mankiw lists ten principles, Stevenson and Wolfers list four core principles. Krugman and Wells use four principles, Mateer and Coppock use five foundations of economics. These strategies are very similar across texts focusing on core ideas such as scarcity, opportunity cost, trade offs, marginal thinking, incentives, and gains from trade. It's not surprising that textbooks have adopted a common approach. Colander described textbook convergence to explain the incentives to steer textbook content toward common content and approach to the content.

Identifying core principles, topics, or themes and embedding them as learning strands that tie the introductory content together, provides scaffolds, or structures upon which later knowledge can be built. They also enable instructors to leverage key cognitive teaching strategies such as retrieval practice and interleaving. As professors return to these core ideas at several different points in the course and apply them to different situations, students build a more complex, nuanced, and complete understanding of the idea; they develop mental models.

Another strategy is to use simple models with visual components as core ideas. These simple models can be used in a similar way – introduced early in the text as a thinking guide, and then inserted in other places in the course as students build their mental framework. Reintroducing the models at different points encourages students to see the connections between the ideas and build a more complex and complete understanding of how the economy works. Using simple models instead of, or in addition to, the core principles that textbooks already utilize has the potential of capturing several of the learning components in a single model, and being visual in nature, which can lend another avenue of understanding for students.

We suggest using two simple economic models, the circular flow model and the production possibilities frontier. Both models are easy to describe and understand, and include underlying ideas that both reinforce each other, and complement each other.

The circular flow diagram is a simple model that shows the "flows" within the economy – the flow of resources, the flow of goods and services, and the flow of money. Students might be tempted to think of each of these and distinct ideas, without seeing that they operate within the same system. In fact, it's important for students to see the interdependencies between these systems – each factor impacts and determines the others.

The production possibilities frontier is another simple model that shows exactly what the name implies: the model shows possible combinations of production using its available resources, with the economy pictured as producing two goods, or two categories of production, one on each axis.

Of course, models are simplified versions of reality, so it's important for students to understand that models are reflections of how the economy works, but the economy is not as mechanical as the models might suggest.

Below we have described a strategy for using the circular flow diagram in an introductory economics course.

Week 1: Introduce the circular flow diagram using direct instruction and reinforced with another resource such as textbook or article. In addition, there have been several active learning lessons that engage students as actors in the circular flow – if your classroom and class size allow, these active learning lessons are enjoyable, but research also suggests that active learning is effective. Then at key points in the course (interleaving), remind students of the circular flow, ask them to recall key concepts and learning objectives (retrieval), and apply the core concepts to the new application. Here are some examples:

Micro
The factors of production (land, labor, capital) are introduced as resources that households own, and businesses buy in the resources (output) market.

Supply and demand is normally addressed first in the product market. So, the circular flow can be used to show how households act as the demanders of goods and services in the product market, and businesses are the suppliers in the product market. Both sides of the circular flow are necessary for the market to work, just as both the supply and demand curves are necessary to generate an equilibrium price and quantity.

Labor market focuses on the resource market, where businesses are the demanders of resources, and households are the suppliers of resources. Again, stress that both sides of the circular flow are necessary for the market to work.

Macro
How markets interact: Establishing the economic actors and markets, input markets (businesses buy resources from households), output markets (businesses sell goods and services to households), and government establishing the rules of the game and can interact to regulate and smooth business cycles.

Business Cycle / Economic Shocks
Economic Shocks are broken connections: Supply or demand shocks disrupt the flow of economic activity. Because the actors are interdependent in this flow of resources, goods and

services, and money. Or, in other words, the input and output markets are dependent on each other – a disruption in one side impacts the other.

Economic Intervention is sometimes needed when the connections are broken. This is where fiscal and monetary policies come in – they can be used to mend the broken connections and return the flow. Fiscal policy can use its spending powers to create demand for goods and services. Monetary policy can use interest rate policy to encourage spending, or lending programs to improve balance sheets and provide the banking system greater ability to lend into financial markets.

Economic Outcomes such as economic growth, unemployment, and inflation can be modeled, as concepts, on the circular flow. In fact, these measures can be used to assess the flow of inputs, outputs, and money throughout the flow.

- GDP measures economic output. If there is a disruption of demand by households for output, or the ability of businesses to produce output, or a change in interest rate policy, the flow will be affected.
- Unemployment measures demand for labor, which businesses demand and households supply. An interruption on either side will impact the flow of labor and impact unemployment.
- Inflation measures changes in the price level. Because resources are limited, as they become more scarce, prices will rise as households and businesses bid up their prices. In fact, inflation is measured on both sides of the circular flow, the consumer price index measures the household inflation rate, and the producer price index measures the business inflation rate. If too much money is chasing too few goods – households are demanding goods and services at a rate that exceeds the ability of business to produce, inflation will increase.

Measuring GDP. We often tell students that economists can measure GDP using either the income or expenditure approach because they are two sides of the same transactions. An expenditure for one person is income for another. In the circular flow this is evident as input and output markets, in the flow it is intuitive that aggregate spending is equal to aggregate income.

Economic Growth can be modeled as investment in capital that increases its ability to produce goods and services. This increase in output also creates demand for inputs. In this case, the model grows and flows are larger.

The PPF is another simple model that can be used to connect ideas across the curriculum for students.

Week 1: Introduce the production possibilities frontier using direct instruction and reinforced with another resource such as textbook or article. Then at key points in the course (interleaving), remind students of the circular flow, ask them to recall key concepts and learning objectives (retrieval), and apply the core concepts to the new application. Here are some examples:

Micro
The PPF is a useful tool for laying down the course foundations, and then building later.
Factors of production. The PPF represents what an economy can produce given its available resources – land, labor, capital.

Scarcity – the PPF represents what the economy can produce (on or within the frontier), and what it cannot produce (outside the frontier).

Opportunity cost – Picking two points on the frontier and moving from one to the other displays the concept of opportunity cost – producing more of one good means giving up the opportunity to produce another good.

Tradeoffs – production all along the frontier shows the tradeoffs of choosing different production levels, or allocating resources differently.

Business Cycle
Recessions can be discussed on the PPF by first discussing a production level inside the frontier, representing an economy that is producing at a level that does not fully employ its available resources.
Expansions can be modeled on the PPF starting from recession (point inside the frontier) and moving outward to the frontier.

Potential output is represented by the frontier, producing on the frontier is producing at potential, inside the frontier is below potential (negative output gap), and outside the frontier (positive output gap).

Long-run aggregate supply curve and potential output are reflective of the frontier because they represent potential output with available resources.

Economic growth (as distinct from economic expansion) is modeled as the outward shift of the frontier. It's important to use the PPF as a tool to point out that a shift from inside the frontier (recession) toward the frontier demonstrates economic expansion, or recovery, while an outward shift of the frontier due to an increase in resources or technological advance demonstrates economic growth.

Fiscal and monetary policy can be introduced in this context – an effort to move the production point toward full employment, or from a point inside the frontier back toward the frontier.

Inflation / Phillips Curve While the Phillips Curve has flattened over time, the model can be a useful way to describe how resource scarcity can lead to rising price levels. On the PPF, moving from a point inside the frontier toward the frontier suggests resources are becoming more scarce, which creates inflationary pressure. As an economy pushes toward the frontier, or even pushes past the frontier (positive output gap), the economy will likely experience rising inflation

because it is producing beyond its long run capacity. Of course, as the economy reaches it's frontier, it nears full employment -- the other side of the Phillips Curve.

Gains from Trade can be expressed after teaching specialization, comparative advantage, and the gains from trade, by plotting each country's consumption on the PPF pre-trade (where the country consumes only what it produces), and post-trade. Often the very same illustrations that professors are already using to discuss comparative advantage can be plotted, and the gains from trade shaded on the graph to visually identify the gains.

Applying Cognitive Science Concepts to Teaching an Economic Literacy Course

Before describing how one might teach an economics literacy course, it is helpful to review a bit of cognitive science (some of the following discussion is similar to that in Boyle and Goffe (2018). A substantial amount about how people learn has been discovered by researchers in this discipline, but there are few incentives for economists to learn about these findings. Cognitive science can help give instructors knowledge to design a firm foundation for their courses. Further, experienced instructors may well have observed aspects of these concepts, so the following may well be filling in details of their experiences.

One overarching concept from cognitive science that is used by STEM educators is "constructivism." Hartle, Baviskar, and Smith (2012) define it as "...a theory that describes learning as taking new ideas or experiences and fitting them into a complex system that includes the learner's entire prior learning. In other words, students arrive with pre-existing 'constructs,' and in order to learn, must modify these existing structures by removing, replacing, adding, or shifting information in them." Thus, instructors need to be aware that students likely bring ideas and concepts to even a first-year introductory course and these constructs might be resistant to change as they have served students well to date. Staples et al. (2020) illustrate this point with student reasoning on simple supply and demand problems – even after instruction, they seem to retain incorrect notions of how this simple model works.

"Schemas" are another concept from cognitive science that economics instructors will likely find useful. When we teach, we are hoping to change how our students think about economic topics. Thus, it is important to understand how human brains store information. Cognitive scientists argue that we store information in "schemas," or networks of ideas, concepts, and procedures. Each of these is a node and our minds connect these nodes to each other to greater or lesser degrees. This framework helps explain why we generally have an easy time remembering something that is connected to something we already know (e.g. the paper you read yesterday that is a variation on a paper you wrote last year) while isolated facts are difficult to remember (e.g., phone numbers in the days before contact lists in our cell phones). Thus, instructors are in the business of changing schemas. One excellent discussion of schemas as applied to college instruction is Ambrose et al. (2010, Ch. 2).

Not surprisingly, experts and novices have very different schemas – experts have a rich set of connections between concepts and procedures and they see the "deep structure" of a subject, while novices have weak or no connections between concepts and procedures. For instance, a student in a literacy course might not connect similar topics, like own-price elasticity and income elasticity, or they might not understand some of the similarities of supply and demand curves. Instead, they may see each topic as isolated from other topics. Schemas help explain why scaffolding aids instruction – the instructor slowly introduces topics or procedures that build upon the previously understood topics so as to build students' schemas.

Students' weak schemas can help explain why learning may not be durable. While students might be able to answer homework and exam questions, weak schemas can lead to forgetting as the weeks and months go by after a course is complete. To combat this forgetting, courses should have students build many connections between course topics to strengthen their schemas. An economic literacy course might have an advantage here in helping students remember as the same handful of topics are frequently repeated throughout the semester.

Students' schemas might not be obvious to instructors due to the "Curse of Knowledge." This cognitive bias can afflict experts – it describes how they often have a difficult time understanding how novices think about a topic. One implication is described by Wieman (2007): "Students can think about a topic in ways quite unimagined by the instructor, and so a lesson that is very carefully thought out and is beautifully clear and logical to experts may be interpreted totally differently (and incorrectly) by the student." Many instructors likely have experienced the Curse of Knowledge when a student question surprises them with its naivete, a shockingly wrong conception of a topic, or invokes a framework that the instructor never considered.

Instructors should also be aware of human's limited "working memory," which is how many different "chunks" of information we can manipulate when thinking. This limitation was nicely illustrated by Steve Chew in his plenary address at the Conference on Teaching and Research in Economic Education (CTREE) in 2019 when he asked, "What are the days of the week?" Then, with a pause he added, "Oh, in alphabetical order by the first letter of the day." Despite one's familiarity with these very common words, most find this to be a challenging task due to our limited working memory. Miller (1956) found that human working memory is limited to roughly seven chunks of information. Further, for a given subject, experts can manipulate larger "chunks" than novices. For example, an economics instructor might be able to mentally visualize all of a circular flow diagram at once while a student cannot. Limited working memory is another reason for scaffolding – this teaching method avoid swamping students' working memory. For more on the impact of working memory in teaching, see Hultberg and Calonge (2017) and Chew and Cerbin (2021).

All of the above concepts are important reasons why students should be exposed to topics before class and hopefully learn a bit about them (Chew and Cerbin (2021) back up this suggestion). Constructivism and the Curse of knowledge suggest that it is helpful for instructors to understand the ideas and concepts that students bring to class and which concepts and ideas they find difficult (or, what are the "holes" in their developing schemas). As above, instructors

are likely to be surprised by student difficulties and prior conceptions. Further, if students learn a bit before class it is less likely that their working memory will be swamped in class when they are exposed to numerous concepts.

What kind of pre-class work might instructors assign? One possibility is a low-stakes quiz after students read an assignment or watch a video. One specific type is a “Readiness Assurance Test” in Team-Based Learning, where students take a reading quiz individually and after turning in their results, they take it again as part of their permanent team (these are sometimes called a “two-stage exam’” see Simkins et al., 2021). Another possibility are “JiTTs” (Just-in-Time Teaching assignments; see Guertin et al. (2021) and Simkins and Maier (2010) where students answer short-answer questions on a reading in their course management system. One question often used with JiTTs is one along the lines of “What did you find puzzling, confusing, or surprising in this reading?” Another possibility is social reading software, like Hypothesis, https://web.hypothes.is/ or Perusall https://perusall.com/ . Students jointly read an assignment and together ask and answer questions on the text. Perusall can generate a “confusion report” for instructors to catalogue student prior conceptions and difficulties.

As described below, class should be active, but this hardly means that the instructor only leads active learning activities. It is important for the instructor to set the stage for course topics. This point is emphasized by Bain (2004), who found that leading instructors oriented their courses around answering enticing questions, with the implication that course topics are valuable and worth spending time learning. Chew and Cerbin (2021) make a related point about student mindset – in part, students should find their work in a course to be valuable.

Deslauriers et al. (2011) argue that classes should be spent in a specific type of active learning – “deliberate practice.” This concept comes from the work of Anders Ericsson, a cognitive scientist who studied how experts become experts. In Ericsson and Pool (2016) deliberate practice is defined as activities that

- are just beyond current abilities
- require one’s full attention
- timely and accurate feedback is given
- schemas are developed and enhanced

Ericsson and his colleagues argue that experts become experts when they undertake such activities, and Deslauriers et al. (2011) apply it to teaching a second semester physics course. For one week, one section was taught using deliberate practice and another was taught using a standard approach. The following week students were tested on their knowledge from the previous week and students from the class taught with deliberate practice learned much more -- the effect size was 2.5 standard deviations.

Perhaps the most surprising element of deliberate practice is schema development. This includes making connections to related concepts and addressing incorrect prior knowledge. For example, a worksheet on elasticities might not just have students compute them but ask how income and own-price elasticities are both similar and different. For a supply and demand

activity, students might not only describe shifts in curves but also be asked questions that get to the heart of common student misunderstandings as described in Staples et al (2020). Thus, learning is certainly active, but activities are specifically designed to maximize schema formation. Also note how deliberate practice requires one's full attention; in the examples above students had to go beyond what is often asked in entry-level courses and think more deeply about the topics at hand.

Another way to think about deliberate practice is through the aphorism, "memory is the residue of thought" (Willingham, 2008 and 2021). That is, people remember what they think about, and one way to get students to do this is to ask challenging questions that have them think deeply about the topic at hand. Part of asking questions is of course answering them. It appears that learning is enhanced if several different explanations are used (when possible); see Smith et al. (2011) and Schwartz et al., (2016, Ch. A).

If the instructor might suspect that student preconceptions are firmly held, he or she might take an approach used in physics: "elicit, confront, resolve" (Wosilait, 1998). That is, first elicit student views on the topic at hand, confront these views (in a safe way) with other evidence, then resolve this conflict with a better description of the topic. Note how the "elicit, confront, resolve" very much follows a constructivist approach to learning – students can come to class with preconceptions and they can be difficult to truly displace.

There are several established ways to teach a class centered around asking questions. One is "Team-Based Learning," (Simkins et al. n.d. and Simkins et al., 2021) where students are formed into permanent teams that last the semester. "TBL" has pre-class activities built in and class itself is oriented about questions that students answer individually and in their teams. A less structured approach, which is easier to implement for larger classes, involves clicker-based "ConcepTests," which are the type of challenging questions described above. See Wieman et al. (2017). Note that this in-class approach should be paired with some type of pre-class activity, as described above.

The reader might notice that a class organized on the above principles is "flipped," but that is not the key organizing principle. To some instructors, a flipped classroom involves watching videos before class and class itself is devoted to problem solving. The design described above certainly follows this framework, but it is more nuanced. This is a point made in Boyle and Goffe (2018).

Other findings from cognitive science should certainly be used to increase learning and its retention. These include "retrieval practice" (Roediger and Butler, 2011) which is the idea that when one tries to retrieve an idea or procedure from long-term memory, that memory is enhanced. It seems that by recalling information one is telling your brain that that information is useful. An instructor might implement retrieval practice in several ways. One is to incorporate it in questions asked in class (as described above). Or an instructor might start class with low or no-stakes quizzes. Another finding is "spacing," the idea that if one studies material spaced over time it is likely to be remembered for longer periods in the future. This phenomena has been

studied for nearly 150 years and Kyle et al. (2019) find that spacing enhances retention of mathematics knowledge from a college class months after it ends. Spacing implies that course topics should appear repeatedly across the semester; this is perhaps most easily done in homeworks, quizzes, and exams, but it can also be implemented in in-class questions when one topic relies upon a previous one. One particularly interesting paper that applied spacing and retrieval practice to a college class is Butler et al. (2014).

Cognitive science even has something to say about how to group homework problems. It might seem best to “block” problem types, where similar problems are solved one after the other. It turns out that learning is enhanced if problems are “interleaved.” That is, problems of different types follow each other. While there is a robust interleaving literature, one of the best-done papers is Rohrer et al. (2020). The intuition behind interleaving is that when problem types are jumbled together students have to determine the best solution method for each problem and thus they are more likely to solve problems correctly at a later date.

Finally, as described in Chew and Cerbin (2021), it likely helps if instructors encourage effective study methods. The literature on the best study methods was exhaustively studied in Dunlosky et al. (2013), while Weinstein et al. (2018) provide a more readable summary. Both of these papers have “spin-offs” for students (and instructors in a rush): Dunlosky (2013) and The Learning Scientists, (2021).

Conclusion

This paper describes both the advantage of a literacy-targeted introductory course and how it might most profitably be taught. The course can be centered around basic models that are repeatedly used to illustrate core concepts. Further, numerous principles from cognitive science can be used to enhance deep understanding and long-term retention.

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