ThoughtSTEM Language Learning Handbook

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1 Introduction

Welcome! This handbook contains learning "tactics" – i.e. algorithms, games, and activities designed to help people become extremely fluent in a variety of programming languages.

If you're a coach, you should use these tactics to do two things:

1. Help help team members learn to code
2. Help team members use the learning tactics in this book, to learn to code

This second point is subtle but incredibly important: You are not just teaching coding; you are teaching people how to learn. This manifests in many ways. You're not just playing games with team; you're teaching them how to play the games. You're not just being a coach; you're teaching them how to coach themselves. You're not just being a teacher; you're teaching them how to teach. You're not just being a leader; you're teaching them how to lead.

What all this means is: as team members become more and more skilled at doing these tactics, you should be giving them more and more responsibility for helping you lead the tactics.

- A **brand new member** might simply follow along as you lead a tactic. That's fine. But...
- A **first-day member** who has done a few tactics already should be capable of helping to explain those tactics to others.
- A **new member** with a few days of class under their belt should be able to help you out as an assistant coach in various ways.
- **After a few weeks, a member** should be able to lead a few easy learning tactics from memory and a few advanced ones if they are referencing this book.
- **After a few months, a member** should be able to lead many tactics on their own from memory and any tactic if they use this book.

Your team will only experience this growth in self-driven learning and leadership if you encourage them to begin taking on leadership roles as soon as possible.

- **Don't**: Only use this book to teach coding.
- **Do**: Teach *how to use this book* while you're teaching coding.

Here's one concrete way you can do that: In this book, you will see tactics that give an instruction to you, the coach. For example:

> **Coach** ➡ hand write the contents of the back of [Challenge-Card] on the bottom half of [The-Whiteboard]

A novice coach might see this instruction and immediately begin writing on the whiteboard.

But let me ask you, who is "the coach"? Remember, it isn't just you. Think of your team members as coaches-in-training from day 1.

Ask *them* to write code on the board. Ask *them* to interpret the instructions for you. Ask *them* to step into your shoes and lead for a few seconds. A few minutes. A full tactic. Two tactics in a row. And so on.

Your team members should always be actively participating as both learners and leaders. With your help, they can simultaneously improve at both.

It can take time. Have patience. Believe in your team members. Believe in yourself.

2 The Language Learning Loop

The core thing you'll be doing as a coach is running a "Language Learning Loop". It's essential that coaches (and coaches-in-training) know what that is and isn't.

2.1 The "Basic"

The most basic thing that can be considered a "Language Learning Loop" is this, which we call the "Basic":

```
UNTIL class is over DO

    Coach ➡ pick challenge-card

    Coach ➡ pick tactic

    Coach AND Team ➡ do tactic together

    Team ➡ officially test on challenge-card
```

A Language Learning Loop is any high level learning algorithm that has these 5 essential qualities:

- **It is a loop**. The part that says

  ```
      UNTIL class is over DO
  ```

  is what makes it a "loop".
- **It involves selecting a challenge card in some language being learned** (e.g. `battlearena`, `html5-lang`, `vr-lang`, or any other ThoughtSTEM language)
- **It involves selecting a tactic** – i.e. a learning algorithm – from this handbook. All tactics in this book are language-independent! That is: any tactic will work for any language. Note, there are many challenge cards, but few tactics. You can (and should!) repeat tactics frequently – but you will only repeat challenge cards if you want to.
- **It involves doing that tactic together with the team** – helping them understand both the code on the challenge card, but also the tactic itself, so that they become better and better learners in the future.
- **It ends with all team members being officially tested** – to see if they can write the code from the back of the challenge card while only seeing the front of the card. Whether they pass or fail, the conclusion of this test is the end of one cycle of the loop – at which point it can begin again with a new challenge card (or the same one).

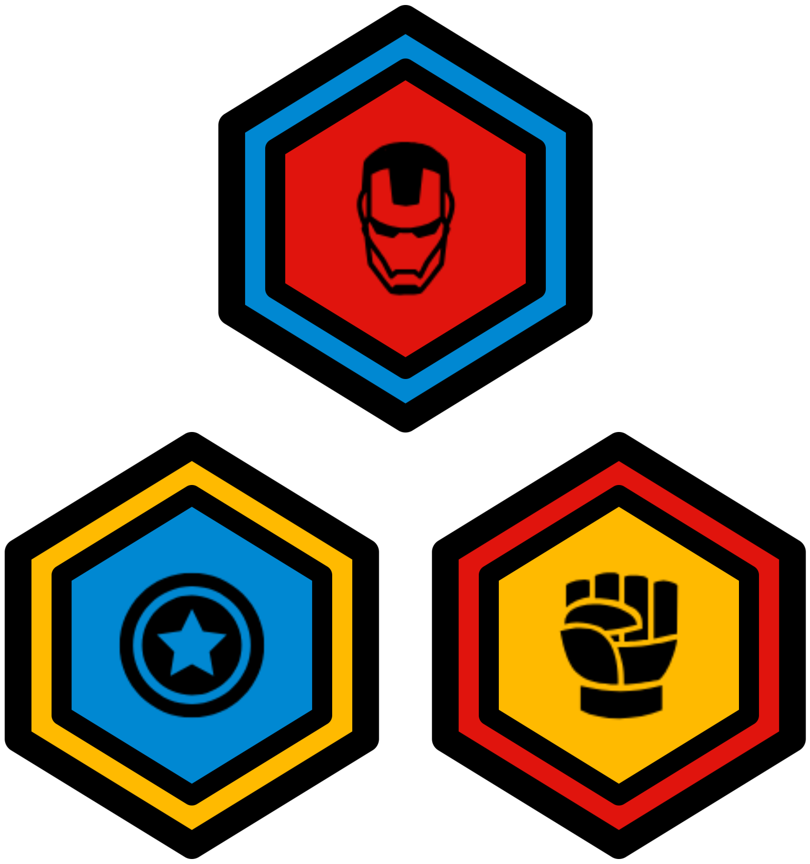
There are as many Language Learning Loops as there are coaches, and we do encourage you to develop your own unique loop (i.e. unique coaching style) over time. However, when you do decide to innovate on the Language Learning Loop, it is essential that you avoid accidentally leading something that does **not** fit the definition of a Language Learning Loop.

For example, this does **not** fit the definition:

```
UNTIL class is over DO

    Coach ➡ pick challenge-card

    Coach ➡ pick tactic

    Coach AND Team ➡ do tactic together
```

It is a loop. But this loop is missing one of the essential qualities! Indeed, it is missing the **most** essential quality of a Language Learning Loop: there is no test at the end!

Remember that team members get badges like these for every ten tests that they pass:



These badges need to mean something. The tests are what help the badges maintain integrity. Tests are not easy to pass; and badges are not easy to earn. It's supposed to be that way.

However, with the appropriate attitude, the learning (and earning) process can be fun – even though it is not easy. That's precisely your job as a coach: to help team members stay excited about challenging themselves, to help them embrace failure as a opportunity, to help them become proud of their hard work, to help them realize that they **can** do this even though it is hard.

There is nothing wrong with the "Basic". Many coaches, even extremely advanced ones, use this exact loop. Also, because it is so simple, it is a great one to teach to assistant coaches (i.e. your team members).

There are other Language Learning Loops, however, with different properties. We'll look at a few now.

2.2 The "Reduce Failures"

Some coaches do not like to see team members fail. That's understandable. This is a loop that greatly increases the chances that all of the team members will pass the test at the end of the loop. It does so by having another loop inside it, in which you **really** make sure that the team is prepared for the test at the end.

```
UNTIL time is up DO

    Coach ➡ pick challenge-card

    Coach ➡ pick tactic

    UNTIL the tactic is completed satisfactorily DO
```

```
        Coach AND Team ➡ do tactic together

    Team ➡ officially test on challenge-card
```

This Language Learning Loop is good for novice members (who tend to be sensitive to failure). The drawback is that it takes longer to get to the test. (Then again, the "drawback" is also the whole point – to delay getting there until members are ready.)

2.3 The "100% Pass Rate"

Here's one that makes absolutely certain that members pass the test at the end of the loop. It works by having an inner loop that has increasingly difficult tests **embedded inside of it**. This means that by the time you get to the test, you've already done the test many times already.

Here's the "100% Pass Rate":

```
UNTIL time is up DO

    Coach ➡ pick challenge-card

    Coach ➡ pick Disintegrating Code tactic

    Coach AND Team ➡ do Disintegrating Code together

    Team ➡ test on challenge-card
```

This is **exactly** the same as the "Reduce Failures" – except that instead of picking any tactic in this book, you must pick the **Disintegrating Code** tactic. This tactic (printed below, and also later in this book) involves a loop where the coach writes code on the whiteboard and removes parts from it until there is nothing left, testing the team at each stage:

SETUP

```
Coach ➡ hand write the contents of the back of [the-challenge-card] on the bottom half of [the-whiteboard]

Coach ➡ hand write the contents of the front of [the-challenge-card] on the top half of [the-whiteboard]
```

MAIN

```
UNTIL the contents of the bottom half of [the-whiteboard] is blank DO

    Coach ➡ remove some identifiers from the contents of the bottom half of [the-whiteboard]

    Team ➡ erase all from the contents of [Team-Computers]

    Team ➡ write a program that fits the requirements written on the top half of the whiteboard
```

By the time the tactic is complete, the team members have written the entire code without any prompting – which is precisely what the official test requires them to do. Thus, the test can be skipped (since they did it during the tactic). No need to test the team twice!

This Language Learning Loop is excellent for sensitive novice team members. It has a drawback, though: It only involves one tactic! There are many tactics in this book. Each tactic helps strengthen different coding skillsets. A well-rounded education does require doing a diverse variety of tactics over time.

This is a great loop to start with, though. (Adding in the **Code Anatomy** tactic into the loop can be a great way to add another dimension to the educational experience.)

2.4 The "Choose Your Own Adventure"

This is a great loop for advanced team members because it gives them more agency over their learning. Here, the tactic is chosen by discussion, and this continues until *the team* decides to move on to the test.

```
UNTIL time is up DO

    Coach ➡ pick challenge-card

    UNTIL team decides they are ready for test DO

        Coach ➡ lead a discussion about "Which tactic should we do next?"
        Team ➡ vote on which tactic to do next
        Coach AND Team ➡ do tactic together

    Team ➡ test on challenge-card
```

This works best with team members who know a variety of tactics and who have developed sufficient metacognitive skill to know which tactics will help them and their team learn most effectively.

It is also a perfect example of the fundamental principle of this handbook: Teach your team how to learn. The more you involve them as active participants in their own learning, the better.

Note, you will need to know when to override the team's decisions if their pedagogical insights are flawed (which will be often):

- If they tend to keep picking the same comfortable tactics over and over, you will need to encourage them to explore new ones and to embrace discomfort.
- If they tend to be reluctant to test themselves, you may need to encourage them to stop doing tactics and take the official test – teaching them that failing a test is not something to be afraid of.
- If they tend to be too focused on taking tests and earning badges as fast as possible, you may need to slow them down and point out that the goal is to learn deeply, not quickly.

And so on...

Remember that training your team to be coaches doesn't mean that you stop being one!

2.5 Language Learning Loops, Conclusion

To conclude, there are many possible Language Learning Loops. You can even create your own. And you are allowed to switch between different loops at will (even in the middle of a class).

As long as a loop contains the essential qualities, it is valid, and you may do it.

Keep in mind, though, the mark of a good coach isn't how cool or complicated your Language Learning Loops are. It's how and what your team is learning.

Are they learning coding? Are they learning how to coach themselves and others? These are what matter.

After just one hour of coaching, you can self-assess with some of these questions:

- **Do your team members know about this handbook?** If not, why were you hiding it from them? The first step to helping them to become better coaches is to reveal the resources that **you** use. Help them understand how **they** can use those same resources.

- **Have your team members seen you use this handbook to lead a Language Learning Loop and at least one tactic?** It's fine if you have the contents of this book memorized (the more you coach, the more tactics you'll memorize) – but you still need to teach "out of the book". Why? Because it implicitly teaches the team how **they** can teach. If they see you using the handbook, they will be less shy about using it themselves when you hand it over to them and ask them to lead an activity. Use the book – and let your team see you using it. It is a mark of an experienced coach if you can simultaneously: 1) teach coding and 2) teach your teaching process.
- **Do your team members know what a Language Learning Loop is? Do they know what a tactic is?** If not, why not? Weren't you doing a Language Learning Loop with them? (You should have been! That's your job as a coach.) If you were, then why weren't you calling it the "Language Learning Loop"? Do use the vocabulary from this book as you lead activities and structure the educational experience. Your team should know words like "tactic", "challenge card", "Language Learning Loop", etc. If you are coaching correctly, these words should be coming up frequently.
- **Would your team members be able to lead a tactic on their own?** If not, that's okay. This can take time for some team members. But ask yourself, what can you do next time to challenge them to take on even more of a leadership role?

3 Disintegrating Code

SETUP

```
    Coach ➡ hand write the contents of the back of [the-challenge-card] on the bottom half of [the-whiteboard]

    Coach ➡ hand write the contents of the front of [the-challenge-card] on the top half of [the-whiteboard]
```

MAIN

```
    UNTIL  the contents of the bottom half of [the-whiteboard] is blank  DO

        Coach ➡ remove some identifiers from the contents of the bottom half of [the-whiteboard]

        Team ➡ erase all from the contents of [Team-Computers]

        Team ➡ write a program that fits the requirements written on the top half of the whiteboard
```

4 Code Anatomy

Coach ➡ hand write the contents of the back of [the-challenge-card] on the bottom half of [the-whiteboard]

Coach ➡ put a box around the #lang line

Coach ➡ put a box around all definitions

Coach ➡ put a box around all top-level expressions

Coach ➡ circle all key-words

Coach ➡ write the total number of key words

Coach ➡ put a dot at the beginning of all parenthesized expressions

Coach ➡ write up the total number of expressions

Coach ➡ above each expression dot, write the expression's nesting depth

If your students forget, here are a some reminders you can show them.

The **#lang line** always comes first and should be self-explanatory.

Here is an example **definition** (anything that starts with `define`). You would put a box around the whole thing (from the parenthesis before `define` to the matching one).

```
(define (foo)
  42)
```

Here is a **top-level expression**. You can recognize it because it doesn't start with `define`, and is not wrapped up inside more code. Below, the `(basic-avatar)` is not a top-level expression, but the containing `(start-game #:avatar (basic-avatar))` is:

```
(start-game
   #:avatar (basic-avatar))
```

A **keyword** is anything with a pound-sign and a colon: e.g. `#:avatar`.

A **parenthesized expression** is anything that starts and ends with a parenthesis. That includes:

- definitions
- top-level expressions
- any expression nested in a definition
- any expression nested in a top-level expression

An expression's **nesting depth** is how many other **parenthesized expressions** are wrapped around it. For example, there are three expressions below:

```
(start-game
   #:avatar (basic-avatar #:sprite (my-cool-sprite)))
```

The `start-game` expression has a depth of 0 (because there are 0 parentheses that wrap around it). The `basic-avatar` expression has a depth of 1, because it is inside the `start-game` expression. And the `my-cool-sprite` expression has a depth of 2, because it is inside the `basic-avatar` expression.

All expressions have a **nesting depth**.

5 Make it More Precise, then Make it More Precise

SETUP

```
Coach ➡ hand write the contents of the front of [the-challenge-card] on the top half of [the-whiteboard]
```

TRANSLATION

```
Coach ➡ announce "Your goal is to all write the EXACT same code on your own computer, silently and independently."

Coach ➡ announce "Before you start, we can translate this prompt into very specific instructions – but only in English, NO CODE!"

UNTIL [Team] feels they can achieve the goal DO

    Team ➡ hand write more specific instructions on [the-whiteboard]
```

CODE

```
Coach ➡ announce "There is NO talking from now until the timer goes off."

Coach ➡ set [timer] for [five-minutes]

UNTIL [timer] beeps DO

    Team ➡ write code independently on [Team-Computers] using the contents of [the-whiteboard]
```

ASSESS

```
Team ➡ compares the contents of [Team-Computers]
```

METACOGNITION

```
Coach ➡
    IF [Team] all wrote exact same code
        congratulate [Team]
    ELSE
        lead a discussion about "How could we get more specific in our pre-code translation?"
```

6 Reverse Engineering

SETUP

```
    Coach ➡ find [the-challenge-card] on [the-kata-page]

    Coach ➡ copy/paste code from [the-kata-page] into [Coach-Computer]

    Coach ➡ run the game
```

MAIN

```
    Coach ➡ show the running game to the team (hide code)

    Coach ➡ lead a discussion about "What are the code-able features of this game?"

    Team ➡ hand write list of code-able features on [the-whiteboard]

    Team ➡ circle the code-able features they don't know how to code

    UNTIL [Team] has hints for all unknown code-able features DO

        Team ➡ write hint next to unknown code-able features using the back of [the-challenge-card]

    Team ➡ write the code to create the game on [Team-Computers]
```

7 Advanced Tactics

These are tactics that are longer and more complex – and a bit more like "games". If the team members have done many simpler tactics, they are ready for these. You can use them as a reward for becoming more adept.

These tactics, due to the complex team dynamics they call for, help to build higher-level skills – i.e. communication, collaboration, leadership, and teaching skills.

Note that the instructions in these tactics may make use of **subroutines** – which are instructions that aren't printed in the tactic itself. It'll look something like this:

> **Team** ➡ Do something
>
> **Team** ➡ Do something else
>
> **GO SUB:**
>
> ```
> #lang ts-tactics
>
> (select-secret-subgroup 'Hackers)
> ```
>
> **Team** ➡ Do something at the end

How many instructions are in the tactic above? It may seem that there are just three or four. But the **GO SUB:** instruction is very special.

Whenever you see one of these, someone on the team must type in the program shown. This will print out further instructions to be followed. When all of those instructions are followed to completion, only then should the instructions after the subroutine be followed – i.e. only after selecting the secret sub group would the team proceed to

> **Team** ➡ Do something at the end

Doing tactics with subroutines requires keeping track of where you were in the tactic before you started doing the subroutine (because you'll need to come back there when the subroutine is finished). It is the team's responsibility to keep these things in mind – which is why these tactics are for advanced teams.

IMPORTANT:

You will need to install/update the `ts-tactics` package to run these tactics. In DrRacket: *File > Install Package...*

8 Mafia

SETUP

Coach ➡ tell the following as a story (be creative) "You're a game development company. The big release is a few days away! The code keeps breaking in the night..."

GO SUB:

```
#lang ts-tactics

(select-secret-subgroup 'Hackers)
```

Coach ➡ hand write the contents of the back of [the-challenge-card] on [the-whiteboard]

Coach ➡ announce the contents of the front of [the-challenge-card]

HACK-AND-DEFEND

UNTIL

EITHER: [Jail] contains all of the people in [Hackers]

OR: [Hackers] have exactly 2 points

DO

NIGHT

Hackers ➡ introduce subtle bugs the contents of the contents of [the-whiteboard]

DAY

GO SUB:

```
#lang ts-tactics

(collaboratively-debug)
```

END-OF-DAY

Coach ➡

IF the contents of the front of [the-whiteboard] has no bugs
add 0 to current points for [Hackers]
ELSE
add 1 to current points for [Hackers]

GO SUB:

```
#lang ts-tactics

(vote-member-into-new-group (not-in 'Jail) 'Jail)
```

META-COGNITION

Coach ➡

IF [Jail] contains all of the people in [Hackers]
lead a discussion about "What are some strategies for when you get picked as a hacker?"
ELSE
lead a discussion about "What are some strategies for debugging code?"

9 Team Memorize

STRATEGY

Coach ➨ announce "In a moment, you must decide which order you will take turns in. You may also strategize during this phase. Do this wisely. After this phase, you will not be allowed to talk freely."

Coach ➨ lead a discussion about the front of [the-challenge-card]

Team ➨ arrange yourselves in a circle (the person to the right of [Coach] shall be [The-Starting-Player])

SILENT

Coach ➨ announce "The [Silent] phase has begun. Any talking during this phase will result in penalties and possibly an instant-loss. Hand signals are permitted. Looking at the challenge card when you are not the owner is forbidden."

Coach ➨ give [the-challenge-card] to [The-Starting-Player]

UNTIL everyone in the circle has had at least 1 turn(s) **DO**

GO SUB:

```
#lang ts-tactics

(pass-and-memorize 10)
```

ONE-TALKER

Coach ➨ announce "The [One-Talker] phase has begun. During this phase, you may only speak or gesture if you own the timer. If you own the whiteboard, you may write or gesture (but you may not speak). All other forms of communication from anyone will result in penalties or an instant loss for the whole team."

Coach ➨ hide [the-challenge-card]

Coach ➨ give [the-whiteboard] to [The-Starting-Player]

Coach ➨ give [the-timer] to the person to the right of [The-Starting-Player]

UNTIL everyone in the circle has had at least 1 turn(s) **DO**

GO SUB:

```
#lang ts-tactics

(timer-holder-talks-to-scribe)
```

TESTING

Coach ➡ announce "The [Testing] phase has begun. All communication is forbidden in this phase. However, you may type on your own computer and look at the whiteboard whenever you want. By the end of this phase, the goal is to have the same code on all of the computers. And it must work correctly! Nod your heads if you understand."

Team ➡ nod

Coach ➡ announce "You have 5 minutes beginning now."

Coach ➡ set 5 minutes on [the-timer]

UNTIL [the-timer] is beeping **DO**

> **Team** ➡ write code
>
> as you wish, but minding the rules of the current phase

META-COGNITION

Coach ➡ announce "The [Scoring] phase has now begun. If the code on EACH computer is correct, we all win."

GO SUB:

```
#lang ts-tactics

(all-correct-post-mortem)
```

10 The End

This handbook is a living document. If you have ideas for more tactics, let us know. We'll be adding more.

Any and all suggestions for improvement are welcome. Email:

`contact@thoughtstem.com`