Description of the "infinite population" version of the discrete model of the "Cultural evolution is rare" paper of Boyd Richerson (1996).

Model parameters:

W_0 = base fitness
δ = probability of individual learner (IL) learning skill
C_ℓ = fitness cost of any individual attempting to learn skill individually
C_s = fitness costs of social learner (SL) learning skill (no penalty for attempt)
K = fitness penalty for being a social learner
D = fitness bonus for knowing skill
n = number of previous generation individuals observed by SL
γ = per generation probability of environment change

Simulation parameters:

G = number of generations

Derived quantities:

p = probability of a previous generation SL being skilled
q = probability of a previous generation individual being skilled
$1-(1-q)^n$ = probability of SL learning skill assuming no environment change
$W_\ell = W_0 + \delta D - C_\ell$ = expected fitness of IL
$W_s = \gamma(W_0 + \delta D - C_\ell) + (1-\gamma)(W_0 + \pi(D - C_s) + (1-\pi)(\delta D - C_\ell))$ = expected fitness of SL

Infinite population model assuming no environment change:

Keep track of:

s_t = frequency of social learners in generation t
q_t = frequency of skilled individuals in generation t

Note: Frequency means relative frequency (out of a total of 1.0). Thus, $1 - s_t$ = frequency of individual learners.

Top-level algorithm:

BoydRichersonInfPop(G,s_1)
  for t from 1 to G:
    learning: produces freq of skilled individual learners and skilled social learners
    proportional selection: produces s_{t+1}

Outcomes of learning and their fitnesses:

Outcome	Probability	Fitness
IL unskilled	$(1-s_t)(1-\delta)$	$W_0 - C_\ell$
IL skilled	$(1-s_t)\delta$	$W_0 + D - C_\ell$
SL social learned skilled	$s_t p_t$	$W_0 + D - C_s - K$
SL indiv learned skilled	$s_t(1-p_t)\delta$	$W_0 + D - C_\ell - K$
SL unskilled	$s_t(1-p_t)(1-\delta)$	$W_0 - C_\ell - K$

where $p_t = 1 - (1 - q_{t-1})^n$ = probability of an SL individual learning skill in generation t

We can calculate q_t by:
$q_t = (1 - s_t)\delta + s_t(p_t + (1 - p_t)\delta) = \delta + s_t p_t(1 - \delta)$
= probability of an individual being skilled in generation t

BoydRichersonInfPop(G,s_1)
  $q_0 \leftarrow 0$
  for t from 1 to G:
    $p_t \leftarrow 1 - (1 - q_{t-1})^n$
    $q_t \leftarrow \delta + s_t p_t(1 - \delta)$
    $indiv \leftarrow (1 - s_t)(1 - \delta)(W_0 - C_\ell) + (1 - s_t)\delta(W_0 + D - C_\ell)$
    $social \leftarrow s_t p_t(W_0 + D - C_s - K) + s_t(1 - p_t)\delta(W_0 + D - C_\ell - K) + s_t(1 - p_t)(1 - \delta)(W_0 - C_\ell - K)$
    $total \leftarrow indiv + social$
    $s_{t+1} = social/total$