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Method Article

An analytical framework-based pedagogical method for scholarly community coaching: A proof of concept

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ABSTRACT

Working in academia is challenging, even more so for those with limited resources and opportunities. Researchers around the world do not have equal working conditions. The paper presents the structure, operation method, and conceptual framework of the SM3D Portal's community coaching method, which is built to help Early Career Researchers (ECRs) and researchers in low-resource settings overcome the obstacle of inequality and start their career progress. The community coaching method is envisioned by three science philosophies (cost-effectiveness, transparency spirit, and proactive attitude) and established and operated based on the Serendipity-Mindsponge-3D knowledge (SM3D) management framework (i.e., mindsponge thinking and Bayesian Mindsponge Framework analytics serve as the coaching program's foundational theory and analytical tools). The coaching method also embraces Open Science's values for lowering the cost of doing science and encouraging the trainees to be transparent, which is expected to facilitate the self-correcting mechanism of science through open data, open review, and open dialogue. Throughout the training process, members are central beneficiaries by gaining research knowledge and skills, acquiring publication as the training's product, and shifting their mindsets from "I can't do it" to "I can do it," and at the same time transforming a mentee to be ready for a future mentor's role. The coaching method is thus one of the members, for the member, by the members.

- The paper provides the structure, operation method, and conceptual framework of the SM3D Portal's community coaching method, which is built to help Early Career Researchers (ECRs) and researchers in low-resource settings overcome the obstacle of inequality and start their career progress.
- The paper presents three major science philosophies envisioning the establishment and operation of scholarly community coaching.
- The paper employs the mindsponge theory and BMF analytics to construct a conceptual framework explaining how an environment is created to help shift members' mindsets from "I can't do it" to "I can do it."

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Introduction

This article aims to present a community coaching platform that is built to support Early Career Researchers (ECRs) and researchers in low-resource settings in doing research: The SM3D Portal (https://mindsponge.info/). The SM3D Portal provides a community coaching method envisioned by three science philosophies of transparency [47], cost-effectiveness [45], and proactiveness [46]. It has operated based on the SM3D (Serendipity-Mindsponge-3D) knowledge management system [56]. The framework is constituted by the mindsponge theory [52,57], serendipity theory [51], the **bayesvl** package [17], and the Bayesian Mindsponge Framework (BMF) analytics [31,32,58]. Before delving into the structure, operation method, and conceptual framework of the SM3D Portal's community coaching method, it is essential to understand the reasons for the platform's development.

Fierce competition in academia and evaluating academics based on publication and citation metrics are generally challenging for all researchers. "Publish or perish" is a well-known maxim representing in stark terms the pressure academics face to publish to advance their career [7]. The pressure appears more striking for early career researchers (ECRs) and researchers in low-resource countries, for they are usually deprived of guidance and lack resources, experience, and knowledge [2]. As a result, they usually encounter multiple setbacks, central to which are mental distress, limited resources, and career dropout.

On the job search front, since it is not easy for ECRs to obtain tenure in their early career stage, they might work multiple successive fixed-term contracts or physically relocate to take up employment opportunities [9]. The ongoing precarity can cause anxiety and hurt their ability to maintain career momentum and trajectory. Another culprit of ECRs is possible career dropout. This occurs because, despite efforts, ECRs sometimes cannot publish their work due to their failure to pass rigorous review coupled with a low rate of acceptance by highly indexed journals or lack of experience impacted by their little exposure to avenues available for publication. Prolonged stress, burnout, and limited job opportunities by a global stagnation in academic positions accompanied by an increase in Ph.D. graduates [10] can overrule the resilience of researchers, which, in turn, can lead to their decision to quit academic careers.

These repercussions have been exaggerated when the budget for scientific research is being cut globally (in both developing and developed countries), and the cost of doing science is getting more costly. Conducting research incurs many expenses, such as professional fees, field schedules fees, costs associated with laboratory experiments, and subscription fees to databases. Other costs during the publication of scientific work include editing services, article processing charges, and open access fees. These are not easily affordable, especially for ECRs and researchers from low-income countries with limited funds.

The situation is further deteriorated by pervasive budget cuts worldwide. In one instance, Guglielmi [12] reported that Mexico's chronically underfunded science now suffered a broader cost-cutting measure leading to the dismissal of researchers in many institutions; alternatively, researchers themselves needed to run crowdfunding campaigns. Budget cut also fuels frustration among academics in advanced countries such as Japan and Australia [6,20], so collaborating with peers in developed countries to access more resources seems less feasible for researchers in developing countries [34]. Thus, costly scientific work and its publication, coupled with declining funding rates, create an environment where ECRs and researchers in low-resource settings face higher risks than ever before [19].

At the same time, there is an ongoing concern about scientific misconduct due to pressure from publication metrics fulfillment. Prevalent general science misconduct includes, but is not limited to, fabricated data, paper mills, and data manipulation. This sent a shockwave to the public when many prestigious organizations and journals conducted the retraction of papers due to fraud or suspected fraud [8]. In one instance, Nobel Prize winner Gregg Semenza has retracted four papers from the Proceedings of the National Academy of Sciences (PNAS) for concerns about images in the articles [38]. Apart from *PNAS, Nature, Science*, and the *New England Journal of Medicine* have also faced massive retraction incidents. Another instance is that the Institute of Electrical and Electronic Engineers (IEEE) has recently retracted 400 peer-reviewed articles [39]. In the same vein, social science and psychology,

in particular, also face their issues, described as reproducibility crises and discussed in some studies, such as the ones by Camerer et al. [3] and Nosek et al. [37].

Given the deteriorating situation of scientific misconduct as well as the pressure and deprivation of resources borne by ECRs and low-resource-setting researchers, one of the founders of the SM3D Portal (https://mindsponge.info/), details of which are revealed below, has proposed his opinions on many prestigious scientific journals (e.g., *Nature, Nature Human Behaviour*, and *Learned Publishing*) and scientific forums (e.g., LSE Impact Blog, Scientific Data Updates, and Times Higher Education) [44–50].

Specifically, the foundational philosophy suggests that research integrity can be enhanced in many ways, from open science to self-critique and other practices, which should then be well communicated to ERCs in the early stage of their career. Indeed, an open review system helps facilitate a transparent discovery process, leading to significant social benefits and improving public trust in science [37]. In addition, ECRs or researchers in developing countries can still progress in low-resource settings if they acquire a proactive attitude, cost-effectiveness consideration, and self-correcting spirit. These science philosophies are the cornerstone to giving birth to the SM3D Portal and constantly invigorate it during its operation. The following section will detail how Vuong's science philosophies have shaped and invigorated the platform.

Taking into account obstacles encountered by ECRs and researchers from developing countries, the SM3D Portal was established to provide a platform to support them through on-the-job coaching activities using the Bayesian Mindsponge Framework analytics method and allow them to communicate and exchange knowledge. Since its official operation on 22nd June 2022, the SM3D Portal has been training 17 ECRs and low-resource-setting researchers affiliated with institutions in Australia, China, Ethiopia, Fiji, India, Netherlands, New Zealand, and Vietnam. The training has led to not only the improvement in their research skills and publishing experience but also the completion of seven manuscripts, of which one was successfully published after four months (Nguyen, [30]).

Therefore, this paper aims to present the SM3D Portal's method-based pedagogical approach to assist ECRs and researchers from low-resource settings, hoping the model can be expanded and replicated. Our paper begins by laying out the background and motivations for supporting ECRs and researchers in low-resource settings. It will then discuss the coaching design or how the community coaching platform works. The next section highlights the three underlying science philosophies of the coaching system. An exemplary training process was also exhibited in the next section. Afterward, we embark on the conceptual framework upon which the ECRs coaching is built. To elaborate, we explain how the platform creates an environment that can shift trainees' mindsets from "I can't do it" to "I can do it." The final part draws upon future directions.

Coaching design

Platform overview: trainees as central beneficiaries

The coaching is executed via an online platform named SM3D Portal. Mindsponge thinking and BMF analytics play the backbone theory and analytical tools in the coaching program. The Portal's name roots from its establishment based on the Serendipity-Mindsponge-3D knowledge management framework, and it is freely accessible at https://mindsponge.info/about, where all information about the framework was explained in detail and linked to the related publications for references. The platform was initially created on 7th April and has been officially operated since 22nd June 2022 by the AISDL team. The team is also the creators of the mindsponge theory [52], the serendipity theory [51], the **bayesvl** R package [17], and the BMF analytical approach [31,32].

The platform aims to train and improve the research and publication skills of ECRs and those from low-resource settings, which is specified in three major objectives:

i Promote knowledge exchange and facilitate worldwide collaboration based on openness, transparency, equality, and innovation;
ii Create opportunities for researchers, especially ECRs and those from the low-resource background, to participate in joint research projects utilizing the BMF analytics; and,
iii Allow participants to discuss interesting findings, achieve products, and gain useful research skills with the core team's theoretical, technical, and editorial support

Through the platform, the team aims to create collaborative projects in which trainees are the main beneficiaries by:

1) Improving research knowledge and skills via rich experiences shared by the AISDL members who have (co)authored hundreds of peer-review research articles in a variety of disciplines, as well as serving as editors and reviewers of hundreds of other articles and books;
2) honing research skills and gaining confidence through the "learning-by-doing" process (i.e., practicing conducting study and writing manuscripts in real projects). It is not a theoretical class lesson *per se*, but the participants will be joining a collaborative project, from the initial conceptualization step to the final response-to-reviewer process; and
3) enhancing the participants' visibility via publications as a result of the training process. The publication must be a peer-reviewed journal, book chapter, or book (preferably indexed in major bibliographical databases, such as the Web of Science and Scopus) (https://mindsponge.info/posts/39).

Throughout the training project, all the project members (trainees included) are considered collaborators who contribute to sharing ideas and completing the assigned tasks under the clear and reasonable guidance of the mentor from the AISDL team. Although the

project mentor gives the directions and tasks of the project, the members are equally contributing to open discussions with the mentor to improve their understanding of the conceptual framework and fundamental theories behind the project scheme, which is sometimes not close to the trainees' expertise. Moreover, all participants are equally credited, and their efforts will be valued appropriately through their actual contribution throughout project implementation.

ECRs and researchers from low-resource settings can join the training project in two main ways. The first way is through the open collaboration system on the Portal. Specifically, the AISDL team will provide interesting problems (such as topics conceptualizations and statistical analysis results) in the Collaborative Projects platform where participants-to-be can view details and apply to participate in projects they are interested in. The registration needs to be done within the registration deadline of the project. After they successfully register for a project, the next stages of the collaborative project (i.e., *discussion and assignment stage, research implementation stage, finalizing and submission stage*, and *revision stage*) will follow. More details of this collaboration system can be viewed here: https://mindsponge.info/posts/39.

The second way is through the AISDL team's invitation. Besides making the collaborative projects widely open on the Portal, the team also actively sends invitation emails to ECRs and researchers from low-resource settings with backgrounds related to the project's topic. Invitees are identified by seeking on online platforms associated with academia (e.g., Google Scholar, ResearchGate, etc.), members' recommendations, and the team's network.

The most recent achievement of the coaching platform is making the first product co-authored by our members published in a qualified journal after four working months: the *Journal of Risk and Financial Management* (*JRFM*) (Nguyen, [30]). The journal is indexed in both Scopus and Web of Science databases. According to the ABDC Journal Quality List, issued by the Australian Business Deans Council, *JRFM* is rated B rank (belonging to the top 27.6% of 2,682 qualified journals). The journal is also affiliated with various scholarly societies, such as the International Engineering and Technology Institute (IETI), the Institute of Data Science and Artificial Intelligence (IDSAI), and the International Research Institute for Economics and Management (IRIEM). It should also be noted that the article's Article Processing Charge (APC) was entirely handled by the team using the APC waiver of one of the team members.

Philosophies behind the coaching platform

The coaching design is envisioned by three core science philosophies: cost-effectiveness, transparency spirit, and proactive attitude [45–47]. A cost-effective mindset and proactive attitude can help researchers strive in low-resource conditions. At the same time, the transparency spirit can contribute to reducing the cost of doing science and facilitating the self-correcting mechanism of science [44]. The intertwining of these philosophies can be easily observed through the platform operation and participant training methods.

The coaching activities are built to guide trainees to conduct research using BMF analytics. To lower the cost of participating in the training, the team has the resources used for conducting research freely open, from the statistical software to the datasets. Specifically, the **bayesvl** package was created on the open-source R platform, allowing all researchers to utilize it for Bayesian inference for free [17]. The package's guiding protocol and a brief version of BMF analytics are also published as open-access articles in *MethodsX* for free accessibility to the content [32,54]. In addition to the method, the team's materials are also submitted to data journals, such as *Scientific Data, Data in Brief*, and *Data* [13,26,27,43,53,55], or deposited to open repositories, such as The Open Science Framework (OSF), to make it widely accessible and to enhance the reusability of the resources.

During the training process, the team encourages participants to adopt a transparency spirit and a proactive attitude to make use of secondary data available in data journals (e.g., *Scientific Data, Data Intelligence, Data in Brief*, and *Data*), open data sharing platforms, and reliable open repositories (e.g., Mendeley Data, Havard Dataverse, Open Science Framework, Zenodo, Science Data Bank, etc.).

To nurture the trainees' transparency spirit, the team also uploads the completed manuscripts to preprint servers and announces them on the coaching platform, along with making the method and data open. By doing so, the team expects to receive early public feedback on the study quality for polishing before the official publication. Besides, in each research project, the team strives to make all the relevant code and data used for conducting the study available in online repositories to encourage reproduction, reevaluation, and reuse. For example, some of the latest collaborative projects and their code and data are deposited in the OSF Preprints and PsyArXiv Preprints:

- https://osf.io/eaxuj, with the code and data deposited at: https://osf.io/n2fb6/
- https://osf.io/rsptq/, with the code and data deposited at: https://osf.io/b9s8r/
- https://psyarxiv.com/4y2q5/, with the code and data deposited at: https://osf.io/z8pqn/
- https://psyarxiv.com/x95f8/, with the code and data deposited at: https://osf.io/e6zku/
- https://psyarxiv.com/eds78/, with the code and data deposited at: https://osf.io/h8gq7/

The three science philosophies are also expressed clearly through the design of the trained method of the coaching platform: the BMF analytics. With the following characteristics, BMF analytics can help researchers work effectively and efficiently with limited resources and promote open science [35].

First, BMF analytics is not a data-intensive method. As the analytics is the combination of mindsponge theory and Bayesian inference, it inherits the estimation power of Bayesian inference when the priors are correctly specified [24,40] and the reasoning strength of mindsponge theory based on set theory logic to improve the precision of prior specification (Vuong, [58]). These advantages allow researchers to work well with small sample-size datasets.

Second, the method allows users to capitalize on secondary data available in data journals and online repositories. The mindsponge theory's generalization and flexibility in explaining human psychology and behaviors allow users to reconstruct used datasets to explore the studied phenomenon more deeply or reexamine the subject from the information-processing perspective. In addition, with its fundamental feature of treating all properties probabilistically and the assistance of Markov Chain Monte Carlo (MCMC) algorithms [5,11,18], Bayesian inference can help users fit various types of models, ranging from parsimonious to highly hierarchical models [4,61]. This capability of BMF analytics has been tested and validated by several studies reusing materials in data journals for more in-depth research [15,16,26–30,33,60,62]. Two recent collaborative projects with trainees also employed datasets not designed and collected by the AISDL team, namely:

- "Mindsponge-based investigation into the non-linear effects of threat perception and trust on recycled water acceptance" employed the dataset of Vila-Tojo et al. [42] and shed light on the non-linear relationships between threat perception, trust, and recycled water acceptance for drinking. The dataset had been used in the study of Vila-Tojo et al. [41] earlier.
- "Examining the influence of generalized trust on life satisfaction across different education levels and socioeconomic conditions using the Bayesian Mindsponge Framework," which employed the dataset of Martínez [21] and argued that generalized trust might have different impacts on life satisfaction across education levels and socioeconomic conditions. The dataset had been used in the study of Martínez, Estrada, and Prada [22] earlier.

For completing the training process, participants are encouraged to adopt a proactive attitude. Specifically, when giving tasks to trainees, the mentor focuses solely on communicating the project's core ideas and directions to complete the tasks but not exactly what to do. Doing so gives trainees the freedom to explore new knowledge and proactively apply creative thinking when completing tasks. Later, the mentor will validate the knowledge and thoughts and give feedback to the trainees. Additionally, a strict deadline is vital to maintain self-responsibility, discipline, and teamwork productivity during a project. Therefore, the mentor and trainees reach an agreement on the deadline for the task to be completed at the beginning of the project. Then, the mentor is in charge of keeping track of the task progress and deadline, while trainees are responsible for completing the given task by the deadline.

Exemplary training process

During the training process, each trainee is assigned a particular task along with the direction to finalize the given task by the mentor. Such tasks can be writing the literature review, doing the analysis, describing the materials or method, presenting the results, and/or adding more ideas to the discussion. To demonstrate the training process more clearly, the following summary is focused on explaining how trainees are guided to perform the Bayesian analysis and result presentation in the recently finalized project: "Exploring factors contributing to creativity performance among entrepreneurs using the Bayesian Mindsponge Framework."

The study's preprint version is published at the following address: https://osf.io/zusbt/.

All the data and code of this study are deposited here: https://osf.io/g8r92/.

The first step is the selection of trainees who possess relevant backgrounds and a willingness to learn more about analytical knowledge. The selected trainee was later provided with an overview of the project and asked whether he/she was interested in joining the project and conducting the Bayesian analysis. Adhering to the code of conduct of the SM3D platform, the trainee's identity is not disclosed due to privacy issues. However, more details about the trainee will be given upon reasonable request and the trainee's acceptance.

After the trainee accepted to take on the Bayesian analysis task, the mentor (M.-H.N.) provided the trainee with the provided data and code employed to perform the Bayesian analysis tasks, along with the instruction. The instruction includes:

1) How to use the data to proxy the studied subjects (e.g., entrepreneurs' creativity, information within the entrepreneurs' minds, and information from beyond the entrepreneurs' minds),
2) How to construct and fit the models using the **bayesvl** package, and
3) How to present the results in a transparent, logical, and concise way.

The mentor ran the code several times to ensure that the code operated well before sending them to the trainee. For pedagogical purposes, the code was separated into four steps with a clear explanation for each step: 1) preparing the data, 2) constructing the model, 3) fitting the model, and 4) visualizing the results and diagnoses. The mentor also provided the trainee with appropriate reading materials to understand the code and its meaning and encouraged the trainee to proactively ask questions to which the answers cannot be found in the provided materials. For example, the Bayesian analysis protocol using **bayesvl** was sent to the trainee [54]; the mentor indicated the sections containing information that helped answer the trainee's questions in the methodological book (Vuong, [58]). The trainee used the following code snippet to prepare the data and construct Model 4 in the study:

```
# Preparing data
dat <- read.csv("C:/Users/ACER/… /2015Ent3071.vn.goc.csv", header = T)
require(dplyr)
dat$TransMind <-
case_when(
dat$X19.msponge %in% c("strong") ~ 4,
dat$X19.msponge %in% c("some") ~ 3,
dat$X19.msponge %in% c("negl") ~ 2,
dat$X19.msponge %in% c("none") ~ 1
)
dat$InternalInfor <-
case_when(
dat$X1.job %in% c("hmr") ~ 1,
dat$X1.job %in% c("salesm") ~ 1,
dat$X1.job %in% c("pom") ~ 1,
dat$X1.job %in% c("finance") ~ 1,
dat$X1.job %in% c("admin") ~ 1,
dat$X1.job %in% c("none") ~ 0
)
dat$ExternalInfor <-
case_when(
dat$X10.failurel %in% c("a") ~ 3,
dat$X10.failurel %in% c("b") ~ 2,
dat$X10.failurel %in% c("c") ~ 1
)
dat$EvaluatedSuccess <-
case_when(
dat$X23.chance %in% c("certain") ~ 4,
dat$X23.chance %in% c("high") ~ 3,
dat$X23.chance %in% c("med") ~ 2,
dat$X23.chance %in% c("low") ~ 1
)
dat$Creativity <-
case_when(
dat$X14.inno %in% c("a") ~ 4,
dat$X14.inno %in% c("b") ~ 3,
dat$X14.inno %in% c("c") ~ 2,
dat$X14.inno %in% c("d") ~ 1
)
dat$TimeforEntre <-
case_when(
dat$X7.tforstart %in% c("g24") ~ 3,
dat$X7.tforstart %in% c("b1224") ~ 2,
dat$X7.tforstart %in% c("less12") ~ 1
)
keeps <- c("TransMind","InternalInfor", "ExternalInfor", "Creativity","TimeforEntre")
dat <- dat[keeps]
dat<-na.omit(dat)
# Design the model 4: Uninformative priors = norm (0,10)
library(bayesvl)
model4 <- bayesvl()
model4 <- bvl_addNode(model4, "Creativity", "norm")
model4 <- bvl_addNode(model4, "ExternalInfor", "norm")
model4 <- bvl_addNode(model4, "InternalInfor", "binom")
model4 <- bvl_addNode(model4, "TimeforEntre", "norm")
model4 <- bvl_addNode(model4, "TransMind", "norm")
model4 <- bvl_addNode(model4, "ExternalInfor_TransMind", "trans")
model4 <- bvl_addArc(model4, "TransMind", "ExternalInfor_TransMind", "*")
model4 <- bvl_addArc(model4, "ExternalInfor", "ExternalInfor_TransMind", "*")
model4 <- bvl_addNode(model4, "InternalInfor_TransMind", "trans")
model4 <- bvl_addArc(model4, "TransMind", "InternalInfor_TransMind", "*")
model4 <- bvl_addArc(model4, "InternalInfor", "InternalInfor_TransMind", "*")
model4 <- bvl_addArc(model4, "ExternalInfor", "Creativity", "slope")
model4 <- bvl_addArc(model4, "ExternalInfor_TransMind", "Creativity", "slope")
model4 <- bvl_addArc(model4, "InternalInfor", "Creativity", "slope")
model4 <- bvl_addArc(model4, "InternalInfor_TransMind", "Creativity", "slope")
model4 <- bvl_addArc(model4, "TimeforEntre", "Creativity", "slope")
model_string <- bvl_model2Stan(model4)
cat(model_string)
```

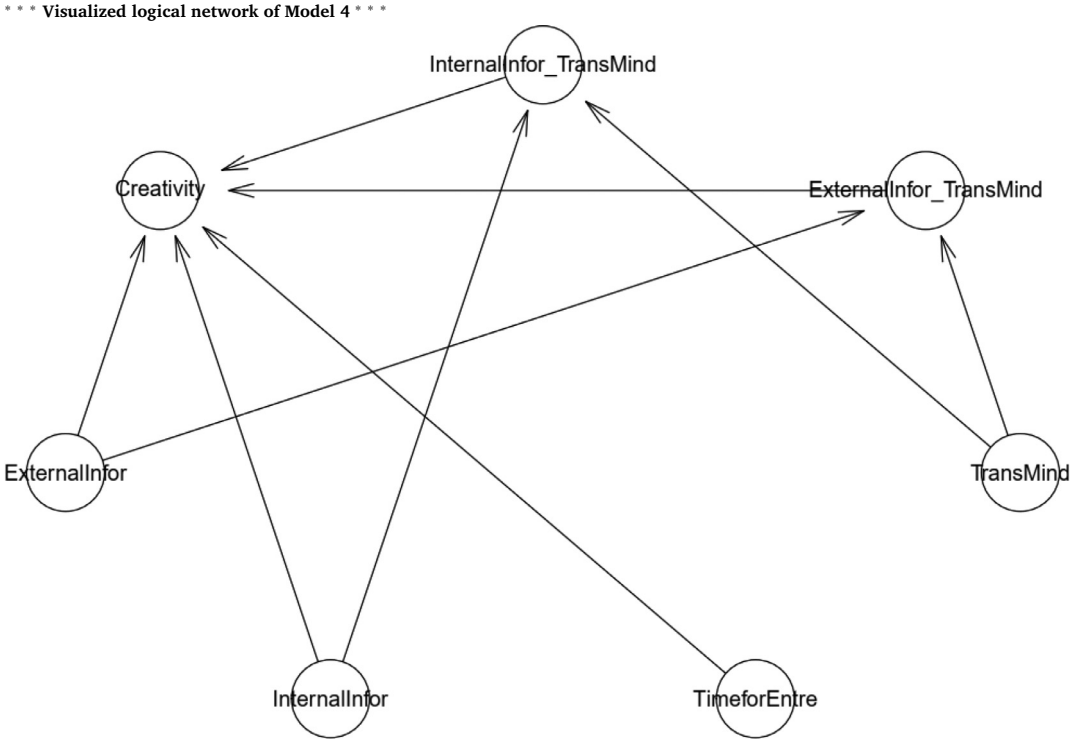
The trainee could check whether the model was correctly constructed using the bvl_bnPlot() function, which displayed the logical network of the built model.

Table 1
Model 4's simulated posteriors. The table is retrieved from: https://osf.io/zusbt/.

Parameters	Mean	SD	*n_eff*	*Rhat*
Constant	1.97	0.09	6211	1
ExternalInfor	0.20	0.06	3989	1
ExternalInfor TransMind*	0.05	0.01	3731	1
InternalInfor	0.14	0.12	3814	1
InternalInfor TransMind*	0.01	0.04	3734	1
TimeforEntre	-0.09	0.02	6760	1

```
# display the logical network
bvl_bnPlot(model4)
```

* * * **Visualized logical network of Model 4** * * *



Then, the trainee could use the following code snippet to fit the model and present the estimated results.

```
# fit the model using appropriate technical parameters
model4 <- bvl_modelFit(model4, dat, warmup = 2000, iter = 5000, chains = 4)
# present estimated results
summary(model4)
```

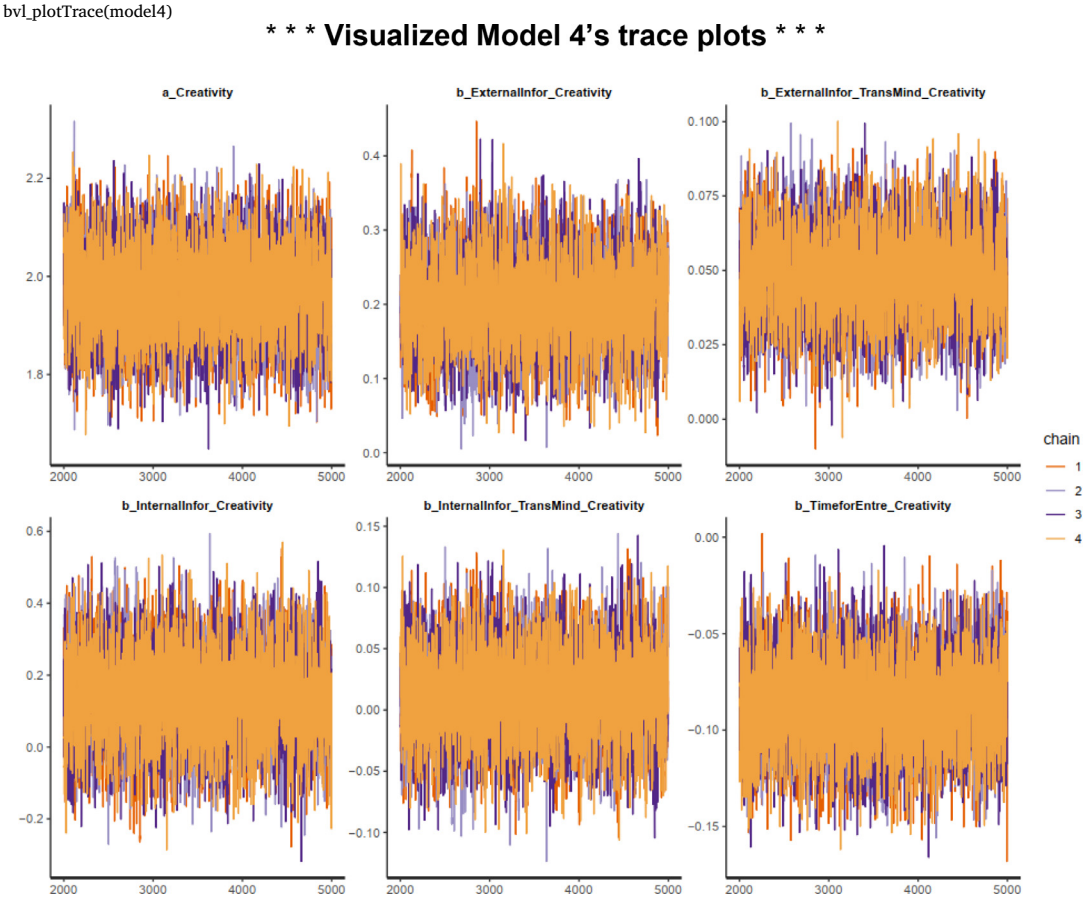
Table 1 exhibits the estimated results shown in the study.

One of the fundamental steps in interpreting Bayesian inference results is to check whether the Markov chain central limit theorem – which assumes that iterative samples in a Markov chain are independent (or convergent) – is held. The convergence can be diagnosed by the effective sample size (*n_eff*) and Gelman shrink value (*Rhat*). Specifically, the simulated samples are deemed convergent if the *n_eff* value is larger than 1,000 and the *Rhat* value equals 1.

Besides, trace plots, Gelman-Rubin-Brooks plots, and autocorrelation plots can also be used to visually diagnose the estimated results' convergence. Therefore, the mentor also provided the trainee with the code snippets to visualize those plots.

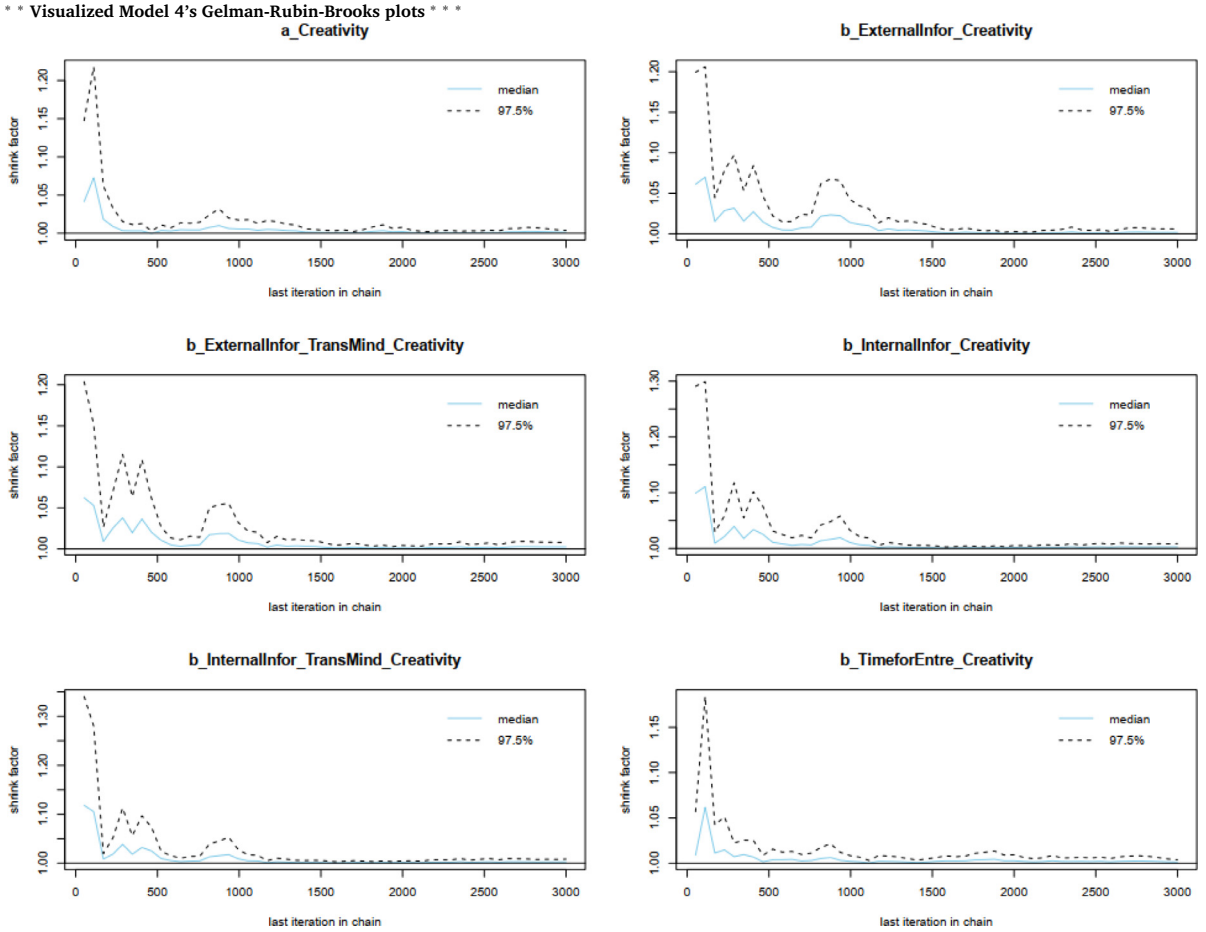
For visualizing trace plots:

```
# visualize trace plots
bvl_plotTrace(model4)
```



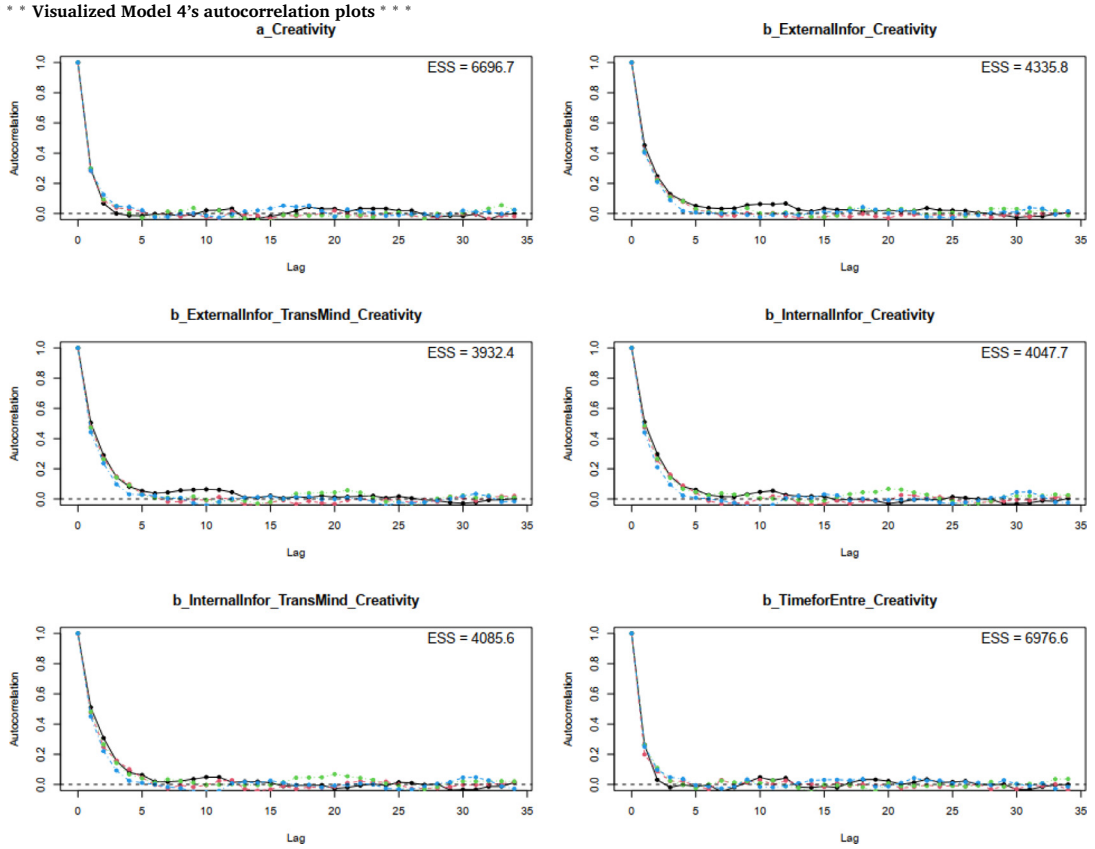
For visualizing Gelman-Rubin-Brooks plots:

 # visualize Gelman-Rubin-Brooks plots
bvl_plotGelmans(model4, row = 3, col=2)
* * * **Visualized Model 4's Gelman-Rubin-Brooks plots** * * *



For visualizing autocorrelation plots:

 # visualize autocorrelation plots
bvl_plotAcfs(model4, row=3, col = 2)
* * * **Visualized Model 4's autocorrelation plots** * * *



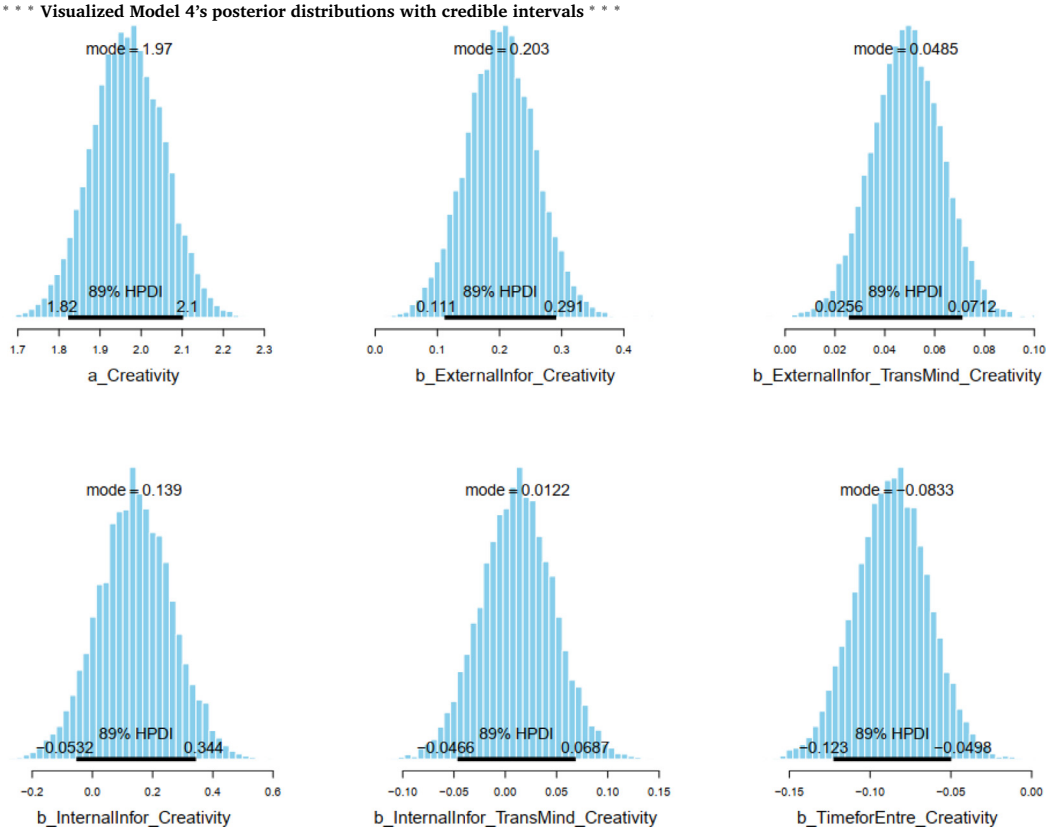
After the participants successfully visualize all the plots, the mentor continues to provide materials that help to interpret them. For example, the trace plot, Gelman-Rubin-Brooks plot, and autocorrelation plot can be briefly interpreted as follows:

- The trace plot depicts the MCMC sample values after each iteration along the chain. The *y-axis* shows the value of the coefficient, while the *x-axis* shows the number of iterations of the Markov process. The Markov chains are said to be convergent if they are good-mixing and stationary around an equilibrium.
- The Gelman-Rubin-Brooks plot is used to see if the Gelman-Rubin factor reduces quickly to 1 before the warming iterations are complete. If the factor drops to one before the 2000th iteration, the simulated samples are said to be convergent.
- The autocorrelation plot depicts the degree of correlation between MCMC samples separated by certain delays. A lag of zero, for example, reflects the degree of correlation between each MCMC sample and itself. The autocorrelation plot has four lines representing the autocorrelation levels among iterative samples created by four Markov chains. If the autocorrelation levels between iterative samples fall to zero after certain finite delays, the iterative samples are regarded as independent, and the Markov chains are considered convergent.

Displaying the parameters' posterior distributions and credible intervals is the main strength of Bayesian inference. Thus, the mentor provided the trainee with the code snippet to plot Model 4's posterior distributions and their credible intervals at 89%.

```
# visualize posterior distributions with credible intervals
bvl_plotParams(model4, 2, 3, credMass = 0.89)
```

* * * **Visualized Model 4's posterior distributions with credible intervals** * * *



After the trainee had successfully constructed and fitted all the models (there are four models in total), the mentor continued to instruct the trainee on how to present those results in the manuscript and recommended the trainee some definitive studies for reference [33,59]. More details of the study's result presentation can be found in the preprint version: https://osf.io/zusbt/.

The conceptual framework

This section demonstrates how the mindsponge theory and BMF analytics are employed to construct a conceptual framework and, subsequently, an environment that helps shift trainees' mindsets from "I can't do it" to "I can do it." The whole mindset-shifting process includes three stages: 1) the beginning stage, 2) the transitional stage, and 3) the final stage.

Beginning stage

For ECRs and low-resource researchers, their collective belief system prior to the training is mainly "I can't do it" due to many setbacks impeding their professional development. The low-resource context in developing countries is a major obstacle for many researchers, especially ECRs, to progress in their academic careers. They lack mentors, funding, literature, and research writing skills [25]. Their publishing-related knowledge is also limited, so their research practices do not often meet the international standards of scientific conduct and ethics, and they can be easily ripped off by "predatory journals" [14].

Even for ECRs in developed countries, despite being able to access funding, many still face difficulties, such as insufficient support and research impairment due to the fierce competition. McAlpine and Amundsen [23] indicate two types of challenges that ECRs usually encounter: day-to-day challenges (e.g., caused by failed experiments and the unpredictable nature of scientific work) and longer-term challenges (e.g., institutional and societal factors-caused challenges such as unsupportive supervisors and ill-connectedness to department structures). The COVID-19 lockdown also exacerbated the research impairment of ECRs as they could not practice their research skills during the data collection process [1].

Altogether, insufficient support and resources lead to low academic recognition and publishing struggles for ECRs and low-resource-setting researchers. Meanwhile, governments' and institutions' resource allocation (e.g., funding, promotion, and tenure) based on academics based on publication and citation metrics also greatly hinder ECRs' and low-resource-setting researchers' opportunities to improve their academic records and worsen their publishing struggles. Nicholas et al. [36] imply that, on average, ECRs

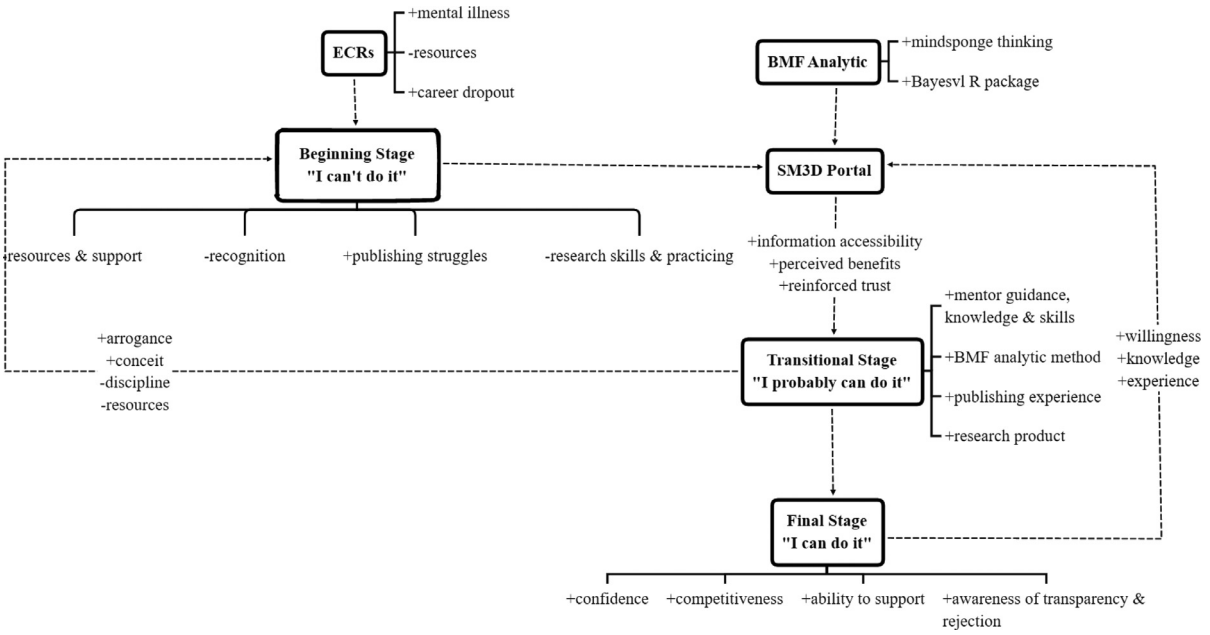


Fig. 1. The information process of ECRs mind shifting

could only be named as the first author for one-third to one-half of academic papers they contributed to and did not have much influence on which journal to submit their papers.

Given that the infosphere in which a person lives substantially influences his/her mindset, such a fierce-competitive and limited-resource environment can easily inject the thinking that "I can't do it" into researchers' mindsets (see Fig. 1). Thus, this mindset is prevalent among ECRs and researchers before participating in the SM3D Portal's community coaching.

Transitional stage

The SM3D Portal attempts to create an environment where ECRs and low-resource researchers can see and capitalize on the opportunities to grow and continue to nurture their motivations to thrive. In other words, the platform provides them with direct support to change their pessimistic infosphere to a more optimistic one. The mindset-shifting process can be separated into three steps:

In the first step, the AISDL team will give ECRs, and low-resource researchers access to navigational and useful information and gain the opportunity to grow [51]. For example, the team will provide potential research directions to new trainees by inviting them to participate in research projects suitable for their careers. Moreover, they are guided to create academic profiles on important scholarly databases (e.g., Scopus, Web of Science, ORCID, Google Scholar, and ResearchGate) and familiarize themselves with useful scientific research tools (e.g., R software, Microsoft Office, Zotero, and Drawio).

In a research project, they will be coworking with mentors to hone their research skills, gain confidence when performing their tasks, and receive immediate support from the mentor. All the information is provided to the trainees little by little through the collaborative process, including the advanced theoretical and technical supports for performing Bayesian Mindsponge Framework (BMF) analytics. When the manuscripts are finalized, the trainees will have a chance to experience working with preprint servers and different publishing systems and gain more journal-submission-related knowledge and skills (e.g., journal-specific format-adjusting, reviewer-feedback-based modification, evaluation of reviewer's comments, and methods responding to reviewers).

The training process is only considered completed when the manuscript is successfully published in a peer-review journal, preferably in the Scopus and Web of Science databases (for increased visibility). Sometimes, a trainee needs several training rounds to gain confidence and acquire sufficient knowledge and skills for conducting research independently.

The three steps above are formulated based on three major conditions of the mindsponge mechanism to change people's minds (Vuong, [58]): 1) make them accessible to the necessary information, 2) make them perceive the benefits of the accessed information, and 3) build their trust toward the accessed information through real products.

Based on our training experience, there is also a possibility that trainees' mindsets bounce back to the low-confidence stage after multiple publications in academic journals. To elaborate, after several successful publications with the help of mentors and the contribution of other teammates, trainees were likely to overestimate their actual research capabilities and become arrogant. The arrogance makes them think that conducting research is easy. As a result, they became frustrated when facing publishing and recognition problems again. Eventually, those trainees became panic and lost confidence rapidly, shifting their mindsets back to the initial stage.

Final stage

The final stage solidifies trainees' "I probably can do it" mindsets and turns them into "I can do it" mindsets. Trainees reach this stage (or have a manuscript officially published) when they have already acquired the skills and sufficient knowledge to meet the standard of scientific conduct and ethics, so they are encouraged to conduct independent research. The research skill sets and publishing experience will make trainees more competitive in academia and have more chances to get recognized and promoted.

Trainees at this stage would also undergo an inevitable experience: many manuscript rejections. However, such rejections are treasures for the trainees to grow. When an ECR or researcher in a low-resource setting work alone, a rejection will harm his/her confidence and increase the doubt over his/her study's values and research abilities. On the contrary, when in the community coaching system, the mentor will evaluate the rejection notice and explain to the trainees the possible reasons behind the rejection. Manuscript rejection does not always associate with the manuscript's quality; instead, it could also stem from the journal's scope, the editor's biases, research values, and the journal's political correctness. Through those experiences, the mentor will also elucidate how science's filtering and self-correcting systems work. As a result, trainees will gain more knowledge about the publishing system and recognize the weaknesses for self-improvement.

This perception about the values of rejection comes from one of the SM3D Portal team's saying:

"We celebrate less on victory; we celebrate more on the failure that helps us recognize our weakness."

Discussion and future directions

Working in academia is challenging, and academic work, to some people, can be unnecessarily costly due to inequality issues. Thus, the SM3D Portal offers a community coaching method to support Early Career Researchers (ECRs) and researchers in low-resource settings in doing research using BMF analytics. The method is envisioned and designed following three core science philosophies: cost-effectiveness, transparency spirit, and proactive attitude.

The three science philosophies are consistently embedded in not only the design of the SM3D Portal and coaching process but also the method used for training (i.e., the BMF analytics). This consistency allows participants to understand and apply the core philosophies quickly. Moreover, the coaching method capitalizes on the power of open science through the use of preprints, open software, open data, and open dialogue. Thus, it helps participants, especially ECRs and researchers from low-resource settings, to catch up with the contemporary practice in academia and ensure research integrity while doing research.

Although the coaching method has acquired several outcomes supporting ECRs and low-resource researchers, it still has limitations. First, the success of the coaching process depends greatly on the participants' proactiveness, self-discipline, and responsibility because participants are not obligated to complete their tasks. Moreover, during a project, the mentor encourages and provides support to help the participants but does not force them to complete the tasks. Participants, therefore, can decide to quit the coaching process at any time.

Second, increasing the number of trainees, the trainees' backgrounds, and training quality require more human and financial resources, which are not currently available.

Training and recruiting more qualified mentors through the coaching process is an effective method for increasing human resources. Successful trainees are invited to join the SM3D Portal to become mentors who would later support more ECRs and low-resource researchers in the beginning stage. Since mentor-to-be trainees had the feeling and thinking of being ECRs or researchers in a low-resource context, they would understand the new trainees' difficulties and needs well. When becoming a part of the community coaching platform, they will have the willingness, knowledge, and experience to offer help and support.

For enhancing trainees' recognition and promoting open science, publishing in Open Access is preferable. Nevertheless, paying the Article Processing Charge (APC) requires a substantial amount of finance. Although the AISDL team manages to use waivers and discount coupons (acquired through serving as editors and peer-reviewers) to pay for the trainees' APC, it is largely insufficient, especially when the number of trainees increases. Establishing a resource pool for pure academic pursuits with APC settlement or any required services from "angel investors" or science funding agencies is feasible, freeing the trainees from unnecessary financial concerns.

Ethics statements

Not applicable

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Ruining Jin: Conceptualization, Writing – original draft. **Giang Hoang:** Conceptualization, Writing – original draft. **Thi-Phuong Nguyen:** Conceptualization, Writing – original draft. **Phuong-Tri Nguyen:** Methodology, Writing – original draft. **Tam-Tri Le:** Visualization, Investigation, Writing – review & editing. **Viet-Phuong La:** Data curation, Software, Writing – original draft. **Minh-Hoang**

Nguyen: Conceptualization, Methodology, Software, Writing – original draft. **Quan-Hoang Vuong:** Supervision, Conceptualization, Methodology, Software, Validation.

Data availability

We have shared the link to the data and code in the manuscript

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Not applicable.

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