

REFLECTIONS ON PRACTICE

Promoting and Supporting Active Learning Strategies in the Face of Changes and Challenges: What, Why and How?

LAM Siew Hong, CAI Hongxia, and XU Weiting

Department of Biological Sciences, National University of Singapore (NUS)

Correspondence:

Name: Assoc Prof LAM Siew Hong

Address: Department of Biological Sciences, 14 Science Drive 4, Singapore 117543

Email: dbslsh@nus.edu.sg

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ABSTRACT

Active learning strategies are effective in engaging and promoting learning as a process of knowledge construction. Building on constructivism frameworks, active learning is not new; however, it has garnered increasing interest in the academic communities. A wealth of empirical evidence and resources that demonstrate why and how it works have been generated. These resources provide sound and useful pedagogic strategies in the face of challenges arising from the changes in teaching and learning needs. Due to the ramifications of COVID-19 and several education initiatives, the NUS Department of Biological Sciences (DBS) is promoting and supporting active learning strategies that are amenable to technology-enhanced learning (TEL) in order to maintain, or even enhance, the quality of learning experiences, and to meet the learning needs of an increasingly diverse student population. To understand the level of awareness and practices of active learning instructional methods in the Department, a survey was conducted among departmental teaching staff. We examined and reflected upon the extent of the level of awareness and practices of active learning instructional methods as well as the challenges and concerns in employing them. We proposed possible strategies to support and promote active learning in the Department in the face of impending changes and challenges in the coming years.

Keywords: Active learning strategies, instructional methods, learning activities

INTRODUCTION

What is active learning?

Active learning is based on the constructivist learning theory which maintains that learning is a process of ‘making meaning’, where the learner constructs knowledge and builds understanding by integrating new information and experiences into existing mental frameworks, or by modifying the existing mental frameworks to accommodate conflicting knowledge (Jonassen, 1991). Constructivist theory asserts that learning is therefore an active process of knowledge construction rather than passive knowledge acquisition, as the learner has to (re-)interpret and integrate information and experiences in the mind, and failing to do so may imply that one has not learned despite having acquired the information or been exposed to the experiences (Alanazi, 2016). Social constructivism further posits that learning occurs mainly through social interaction in a cultural context, and that learners can develop beyond their current ability with the help of scaffolded learning through collaborative efforts between a teacher and peers (Vygotsky, 1978). Social cognitive theory emphasises that social learning involves the dynamic and reciprocal interactions between the learner, environment, and behaviour (Bandura, 1986). Taken together, these constructivist values and theories form the basis for active learning strategies and environments (Grabinger & Dunlap, 1995).

While active learning occurs in the learner/student’s mind, active learning instructional methods are ‘student centred’ learning activities designed and executed by an instructor to engage students in the learning process (Michael, 2006). These instructional methods, building on the constructivist framework, require students to perform learning activities that make them actively think about what they are learning as opposed to passively receiving information (Prince, 2004). They induce students’ cognitive engagement where students put in effort to build understanding by making connections between the information they receive, hence constructing knowledge and even acquiring skills above and beyond listening to a lecture or note-taking (Handelsman et al., 2007). Extending from social constructivism and social cognitive theory, active learning activities often involve peer interaction or group work and they require, as well as promote, higher-order thinking as students interact with the learning materials within the social environment (Freeman et al., 2014). They can occur inside and outside of classroom as part of a module/course that is thoughtfully designed and guided by the instructor.

Does active learning work?

There are substantial published empirical studies on active learning. A focused literature search using certain keywords (such as Boolean logic “active learning” AND “education”), and some filters in three popular literature database for Science, Technology, Engineering, and Mathematics (STEM) disciplines revealed a similar rising trend of publications related to active learning over the past decade (Table 1). Literature databases such as SpringerLink and Scopus revealed a three-fold increase in annual publications related to active learning in the context of education compared to ten years ago, while PubMed, a more specific database for health and life sciences literature, revealed over six-fold increase albeit with a smaller number of publications on record.

Table 1
Number of publications related to active learning (from 2011 to 2020)

Database	Number of publication per year									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SpringerLink	259	353	285	388	428	533	609	670	737	851
Scopus	187	211	224	238	260	277	360	401	471	598
PubMed	32	44	53	76	106	123	123	150	167	206

SpringerLink: Database for scientific documents from journals, books, series, protocols, reference works and proceedings (<https://link.springer.com/>).

Scopus: Database for peer-reviewed publications from life sciences, social sciences, physical sciences and health sciences, including book series, journals, and trade journals (<https://www.scopus.com/>).

PubMed: Database for biomedical literature from MEDLINE, life science journals, and online books (<https://pubmed.ncbi.nlm.nih.gov/>).

These findings suggest rising interest in active learning in the STEM academic communities, including those in health and life sciences, and there are vast resources of empirical studies for active learning. Moreover, there have been large-scale studies published in high-impact journals in STEM communities that demonstrate the effectiveness of active learning instructional methods (Theobald et al., 2020; Freeman et al., 2014; Ruiz-Primo et al., 2011; Haak et al., 2011). These studies, together with the critical reviews on active learning (Michael, 2006; Prince, 2004), provide ample empirical evidence on how and why active learning works.

Why active learning now?

The COVID-19 pandemic and its ramifications have necessitated the shift from traditional learning (TL: physical, face-to-face) to technology-enhanced learning (TEL: fully online, hybrid or blended) that will remain for the foreseeable future. While this shift has created opportunities for educators to embrace TEL, it has also created challenges in adopting the technologies and in using them effectively for teaching and learning. Concerns arising from the notions that TEL is impersonal, less interactive, and less effective than TL have been raised (O'Neill & Sai, 2014; Gherhes et al., 2021). These concerns can be addressed by incorporating active learning activities that require greater interaction between the learner, their peers and instructor so that learning is made more interpersonal and collaborative. Moreover, active learning activities are amenable to technology and can be effectively executed through TEL in a blended or fully online learning environment (Shi et al., 2020). Therefore, active learning activities can help to maintain, or even enhance, the quality of learning experiences regardless whether it is TEL or TL.

The NUS Department of Biological Sciences (DBS) Teaching Committee is therefore proactively seeking to promote and support active learning instructional methods. The established theoretical foundation of active learning provides a sound basis to build on and the large number of empirical studies, especially in the STEM communities, offers a reservoir of resources for educators to draw from when using active learning as a pedagogic strategy to enhance the teaching and learning experience.

SURVEY AND REFLECTIONS

An online exploratory survey was conducted and analysed by the co-chair of DBS Teaching Committee's Co-chair, with the support of DBS full-time Teaching Assistants (FTTAs), to understand the awareness and practices of active learning methods amongst DBS academic staff, and the concerns or challenges they face. The survey also sought to understand the receptiveness of staff towards possible strategies to promote and support active learning by the Department and the University. The survey was conducted during the Departmental Retreat period using the Qualtrics platform through email invitation, and reminders sent to all departmental academic staff. A total of 33 respondents, including seven who provided their input anonymously. Among the 26 respondents who indicated their identities, seven were females and 19 were males, comprising of three professors, one professor in practice, 10 associate professors, four assistant professors, four senior lecturers, two lecturers, one instructor, and one FTTA.

Reflection on awareness and practices of active learning

The survey findings suggested a good awareness among respondents of active learning methods and a strong interest in incorporating active learning activities into teaching (Table 2). Although the survey may have attracted respondents who were more receptive to active learning methods, the findings represented about 50% of teaching staff of the Department (excluding adjunct staff).

Table 2

Awareness of active learning methods and activities

Please rate your agreement on the following statements:	Percentage of respondents (Number) [^]		
	Agree	Neutral	Disagree
1a) I am familiar with active learning methods and how it works	70% (23)	30% (10)	0
1b) There are substantial empirical evidence that support the effectiveness of active learning methods.	85% (28)	15% (5)	0
1c) I am interested to design and incorporate active learning activities into my classes/module(s).	100% (33)	0	0

[^] Percentage is calculated based on total respondents $n=33$

Furthermore, 78% of the respondents employed active learning activities 'frequently' or 'very frequently' in their classes (Table 3). Simple active learning methods such as clarification pauses to encourage thinking and questioning during lectures, a moderately complex activity such as group/online discussion to encourage peer learning, and more complex learning activities such as case studies and problem-based learning that foster greater higher-order and interdisciplinary thinking skills, were among the top active learning activities employed by over 60% of the respondents. On the lower end, writing activities during class (e.g. a minute paper where students have to list down major points or address questions related to a topic within a short duration), role-playing and others (such as debate, game-style quizzes, and critical reflection) were employed by less than 30% of the respondents.

Table 3
Employment of active learning methods/activities

Employment of active learning activities in class*	Percentage of respondents (Number)^
None (in the none of the class session)	0
Rarely (in few of the class session)	3% (1)
Occasionally (in some of the class sessions)	19% (6)
Frequent (in many of the class sessions)	56% (18)
Very Frequent or Regularly (in most or all of the class sessions)	22% (7)
Active learning methods/activities employed #	
Clarification Pauses	73% (24)
Group Discussion (in class) or Discussion Forum (online)	70% (23)
Case Studies	64% (21)
Problem-based Learning	64% (21)
Self-Assessment	58% (19)
Hands on Technology	52% (17)
Interactive Lecture	42% (14)
Inquiry Learning	42% (14)
Experiential Learning	42% (14)
Student Generated Questions	33% (11)
Group Evaluation or Feedback	33% (11)
Peer Review	30% (10)
Writing Activities such as the "Minute Paper"	24% (8)
Role Playing	15% (5)
Others	21% (7)

* Question: How frequent do you employ active learning activities during class session?

Question: Which of the following active learning methods/activities do you employ in your modules?

^ Percentage is calculated based on total respondents $n=33$

Reflection on challenges, experiences and needs related to active learning methods

About 70% of the respondents found it ‘slightly difficult’ to ‘difficult’ when employing active learning methods in their modules (Table 4). Competing limited time between content delivery and learning activity during class, lack of resources for active learning, classroom management, and online limitations due to remote teaching, were among the top difficulties and concerns faced by at least 30% of respondents. On the lower end, low student participation, difficulty in assessing effectiveness, not knowing what works, lack of experience, and others (e.g. taking too much of students’ time outside classroom, unpredictable class size, lack of support), were concerns and challenges faced by less than 30% of the respondents.

Table 4

Difficulties, constraints, and concerns related to active learning activities

Difficulty level in employing active learning activities *	Percentage of respondents (Number) [^]
Not Difficult	30.3% (10)
Slightly Difficult	30.3% (10)
Moderately Difficult	33.3% (11)
Difficult	6.1% (2)
Very Difficult	0% (0)
Constraints, difficulties, or concerns related to active learning activities [#]	
Time: Active learning activities take up time and will reduce my time for the content that I need to deliver during class.	49% (16)
Resources: Active learning activities require resources and I do not have the resources to conduct active learning activities in my module.	33% (11)
Classroom management: I am concern that it might be difficult to manage the class during active learning activities and it can be disruptive to the whole class if the activities are not well managed.	33% (11)
Online limitations: I find it difficult to conduct active learning activities in online classes or when teaching remotely.	30% (10)
Resistance from students: Students resist to participate in active learning activities or only the same few students are willing to participate.	24% (8)
Effectiveness: It is difficult to assess the effectiveness of active learning in students hence I am not sure or not convince that active learning activities will be effective in my class/module.	12% (4)
Methods: I am not sure what active learning methods or how to conduct active learning activities that will work for my classes/modules.	6% (2)
Experience: My experience is in traditional lecturing and it works for me and others when I was a student and now as a teacher. As I have no or little experience in active learning methods, it may not work for me.	6% (2)
Others	12% (4)
No concerns or difficulties	12% (4)

* Question: Do you find it difficult to employ active learning activities in your module(s)?

Instruction: The following are some of the constraints, difficulties, or concerns that a teacher might encounter or might discourage a teacher from employing active learning activities in teaching a class/module. Please select those that are closely related to you or described your concerns [you may select more than one]

[^] Percentage is calculated based on total respondents n=33

Several respondents provided text input that offered some insights that can be broadly categorised into ‘experiences’ and ‘needs’ with regards to active learning (Table 5). Those who shared their experiences revealed that they were employing different active learning methods for different purposes, levels, and class sizes with some success or mixed outcomes. Several ‘needs’ were also indicated, such as logistics for effective execution of active learning (small class sizes and manpower), support for staff to develop active learning methods through workshops, clinics, or videos, and educating students on active learning, including soliciting student feedback on their active learning experience.

Table 5

Reflections on active learning (minor editing was applied for clarity and conciseness)

<p>Experiences</p> <p>Active learning is central to my entomology module since all students make an insect collection consisting of both physical specimens and virtual specimens (photographs)...Students are motivated in their explorations knowing that their findings will be lasting contributions to the Lee Kong Chian Natural History Museum.</p> <p>I tried different things in large and small classes. Peerwise for large class, and others for small classes. Mixed results, especially with the large class. Not everyone likes additional work.</p> <p>The purpose for me is to sustain attention and interest, mainly for more conceptual material so that there is a context for students to learn. Much easier to employ on smaller class sizes, where problems/questions can be posed more specifically to individuals. For larger class sizes, need to use technology, e.g. Poll Eveywhere, Kahoot, etc.</p> <p>I use a lot of different active learning methods in the classes I teach from level 2000-4000. One method I used is a double-blinded inquiry-based laboratory activity, with a written lab report. This is a fantastic method for student learning, but requires a lot of advance planning from the teaching staff and is often time-consuming to assess.</p> <p>I used self-assessment for formative learning purpose to engage students with content materials. Peer-review and Group Evaluation are used for writing and presentation assignments so that students will learn how to evaluate the quality of work. Case Studies and Interactive Lecture are used to get students to think and express themselves regarding certain topics/questions posed to them. Role-playing is used to enhance collaborative learning and communication skills.</p>
<p>Needs</p> <p>Class size must remain small. If large, [it will] need experienced Teaching assistants who believe in active learning and students' education. Staff must not be penalized for trying but receive poor feedback from students.</p> <p>Lack of manpower, especially teaching assistants, in the administration of active learning approaches.</p> <p>A workshop on how to implement active learning into post-COVID online learning would be very helpful. For evaluations, I would welcome student feedback that would allow students to comment on this aspect and a self-reflection on their active learning. I would welcome assistance in collating this student feedback and making a qualitative or possibly even quantitative evaluation of their experiential learning.</p> <p>I think it will be important to share not only the success stories but also examples that failed. This will help us recognise what may be the best for local cohort and how to avoid repeating things that do not work.</p> <p>Have clinics to upgrade faculty, especially for beginners. There must be clear method to upgrade traditional delivery. The steps must be practised, and gradual, with a method to monitor effectiveness.</p> <p>Share short videos of successful implementation of active learning oriented classes.</p> <p>Need to create the awareness of the importance of active learning in NUS students.</p> <p>Inform/educate students what is active learning, improve their acceptance of active learning.</p>

Reflections on promoting and supporting active learning

To meet some of the needs and address some of the challenges faced by respondents in order to promote and support active learning, multi-pronged strategies that could be undertaken by the Department and the University were proposed to the respondents. Over 60% of the respondents considered organising workshops on active learning methods for staff and students separately, and sharing information resources on active learning deemed to be 'effective' or the 'most effective' departmental approaches (Table 6). All the five proposed strategies that can be undertaken by the University, from changing or providing focus on active learning in student feedback, teaching excellence awards, peer review, annual review of teaching performance, to new module proposals, were rated as 'effective' or the 'most effective' by over 60% of the respondents. Taken together, the perception is that while the Department can provide support for active learning, the University can formulate policies and implement practices that can be more effective in promoting active learning.

Table 6
Strategies that can be undertaken by the Department or University to promote and support active learning

Possible Department Initiatives *	Percentage (Number) of Respondents Rated 'Effective=4' or 'Most Effective=5'
Share resources (information/literature) on Active Learning. (n=31)	61% (19)
Organize teaching workshop focusing on 'Active Learning' methods for staffs. (n=32)	81% (26)
Organize DBS learning workshop on the what, why and how of Active Learning for students. (n=32)	69% (22)
Form action groups to support specific Active Learning methods. (n=32)	56% (18)
Recognize and award teaching staffs who adopt methods that successfully activate Active Learning in students. (n=32)	47% (15)
Possible University initiatives #	
Change the questions of student feedback to focus on students' learning and how the teaching has induced or facilitated their learning. (n = 33 for all items below)	82% (27)
Include questions on active learning methods/activities in achieving learning outcomes as part of the focus of Peer-Review.	70% (23)
Change the module proposal template to include active learning activities and factor in 'learner-centered activities' into the planning and scheduling of the module.	67% (22)
Include active learning evidence as evaluation requirements for teaching excellence award	73% (24)
Align the annual teaching performance evaluation with the importance of achieving active learning in students.	70% (23)
* Instruction: The Department can carry out the following activities to promote or support active learning. Please rate the activities using the scale from the Least Effective=1 to the Most Effective=5.	
# Instruction: The University can take the following options to promote active learning. . Please rate the activities using the scale from the Least Effective=1 to the Most Effective=5.	

A case to support active learning for DBS

With the University's launch of the College of Humanities and Sciences (CHS), DBS faculty colleagues are teaching students from diverse science and non-science academic backgrounds with emphasis on interdisciplinary learning. Moreover, the Department also launched three new Master of Science (MSc) by coursework programmes that will further diversify learning needs arising from graduate students and adult learners in continuous education training. Due to the above developments within the Department and University that are occurring within the same time and space, these resulting challenges are felt more acutely and would need to be addressed in the coming years. Active learning activities have been shown to be more inclusive in meeting the learning needs of students from diverse backgrounds (Theobald et al., 2020; Haak et al., 2011). Moreover, active learning strategies can help achieve practice-based or ability-based educational outcomes and are hence suited for continuous education training (Gleason et al., 2011). By employing active learning strategies that utilise dynamic, interdisciplinary, and generative learning activities where students collaborate and become investigators, problem solvers, seekers, or constructors of knowledge (Grabinger & Dunlap, 1995), it can promote higher-order and interdisciplinary thinking skills, nurture

lifelong learners, and prepare students for the complex workforce, thus meeting the education aspirations of the programmes and the university.

Based on the survey findings, the Department can leverage on the strong awareness and interest of its academic staff on active learning (Table 2) to meet the diverse learning needs arising from the new CHS curriculum and the MSc programmes. The Department can create a conducive environment to further promote and support active learning by organising periodic active learning workshops and discussion forums (Table 6). As many of the staff employ various active learning methods (Table 3), they can be workshop facilitators and presenters where they can share their needs-based experiences of adopting and applying active learning strategies in their modules (Table 5). They can also help address difficulties and concerns faced by colleagues during the workshop or through a discussion forum (Table 4). Moreover, the Department can help create e-resources for active learning by compiling contributions from colleagues and other relevant sources. The Department can also source for additional information from the large reservoir of literature (Table 1) to provide ideas for active learning practices and help address some of the challenges faced by colleagues. If there are sufficient levels of interest and commitments, an action group focusing specific active learning methods and recognition awards for excellent effort in this area can be initiated by colleagues and supported by the Department.

Last but not least, active learning awareness must also be created among students (Table 5) because active learning occurs in their minds. The Department can organise learning workshops for students to inform them of the various active learning strategies they can adopt (Table 6). The Department can develop e-resources such as an e-handbook comprising descriptions of modules that highlight the various active learning strategies employed in each module; this is so that students can be more aware and better prepared to participate in these active learning activities carried out by the instructors. It is hoped that as the teacher actively teaches, so will the students actively learn, and active learning practices will become a part of the Department's educational culture as we face changes and traverse the challenges of teaching and learning in the coming years.

ABOUT THE CORRESPONDING AUTHOR

LAM Siew Hong is an Associate Professor and teaches at the Department of Biological Sciences, Faculty of Science, NUS. He is also the Co-chair of the Department's Teaching Committee. His research interests encompass transcriptome, molecular and functional characterisation of adaptive response in organ-tissues of fish and other organisms under specific environmental stressors. He is interested in creating rich environments for active learning and enhancing transferable skills for future-ready graduates.

Siew Hong can be reached at dbslsh@nus.edu.sg.

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