PEDAGOGY FOR EVIDENCE-BASED FLIPPED CLASSROOM – PART 1: FRAMEWORK

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ABSTRACT

This paper presents a pedagogical framework for designing a flipped classroom using an evidence-based approach supported by the use of info-communication technology tools. It firstly explains the swift rise in the flipped classroom approach, and suggests that the main reason for adopting flipped classroom is to address the learning needs of today's learners – the millennials. It argued that the traditional ways of lecturing is no longer compatible with the learning needs of these learners. It offers some explanations of resistance by faculty to adopt the flipped approach despite the apparent benefits it offered. Next, the paper argues for a comprehensive framework for an evidence-based to flipped classroom, using sound pedagogy and understanding based on how humans learn. It points to the lack of pedagogic understanding underlying the design of flipped classroom. Specifically, the paper put forward the following heuristics: (1) Good learning design is *always* grounded on evidence-based practice, incorporating Core Principles of Learning; (2) Information-communication technologies are used *strategically* and *creatively* to enhance specific aspects of the learning process, (3) The completed blended learning design *maximizes* the affordances of a range of learning modes and mediums. Using these heuristics, the paper then shares a model of flipped classroom which we feel is applicable for adoption in any given discipline. The paper explains the key features of the framework, focusing in detail how the core principles of learning are being applied to the design, delivery and assessment aspects of flipped classroom. In addition, the thoughtful use of info-communication technologies (ICTs) to support flipped classroom is also explained. The paper then provides a discussion on the present status of flipped classroom, and concludes with a reminder that the flipped classroom approach still warrants further investigations. It calls for continual improvement of the approach using the framework proposed. (296 words)

KEYWORDS

Flipped Classroom, Evidence-based Approach, Info-Communication Technology, CDIO Standards 8 and 12

NOTE: Singapore Polytechnic uses the word "courses" to describe its education "programs". A "course" in the Diploma in Chemical Engineering consists of many subjects that are termed "modules"; which in the universities contexts are often called "courses". A teaching academic is known as a "lecturer", which is often referred to a as "faculty" in the universities.

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INTRODUCTION

It appears that the adoption of flipped learning or flipped classroom is accelerating at an ever-increasing pace. The Flipped Learning Network reported in 2014 that: “Although not a scientific measure, a search in Google in June 2014 resulted in 244,000 hits for the term “Flipped Learning” and 1,690,000 links for “flipped classroom”. Using the same terms in Google Scholar, the number of hits resulted in 314 and 2,530, respectively” (Yarbro et al, 2014). The authors’ own Google search on August 8, 2016 yielded the following: 4,120,000 results for the term “Flipped Learning” and 557,000 results for “flipped classroom”. Using the same terms in Google Scholar, the number of results are 67,600 and 32,400; respectively. The Horizon Report 2015: Higher Education Edition listed flipped classroom as one of the digital strategies with very promising potential – with a time-to-adoption horizon of “one year or less” (NMC, 2015).

WHAT IS FLIPPED CLASSROOM?

Essentially, flipped classroom entails students watching a pre-recorded video and/or other activities such as reading a journal article, visit to a place of interest prior to attending class. The video can be the lesson created by faculty, or other professionally-made titles or educational resources made publicly available via sites such as YouTube. Students are then given opportunity to evaluate their own learning for example via automated quizzes, discussion board posts, or assignments to be reviewed in class. When in classroom, students interact face-to-face with both faculty and peers, thus becoming more active participants in the learning process rather than listening passively to lectures. Faculty designed interesting in-class activities that leverage on the pre-class preparatory work and challenge students in applying higher-order activities such as problem-solving, evaluating designs and decision-making. Faculty can therefore commit precious class-time to monitoring student performance and providing useful formative feedback (e.g. Kim et al, 2014; Hughes, 2012; Zappe et al, 2009).

In terms of Bloom’s taxonomy, under the flipped model, the lower levels (‘remembering’ and ‘understanding’) are presented before class through recorded lectures and videos, and other materials. These provide the foundational support for learning so that in-class time can be spent working on higher levels of learning from ‘applying’ to ‘creating’. This is shown in Figure 1.

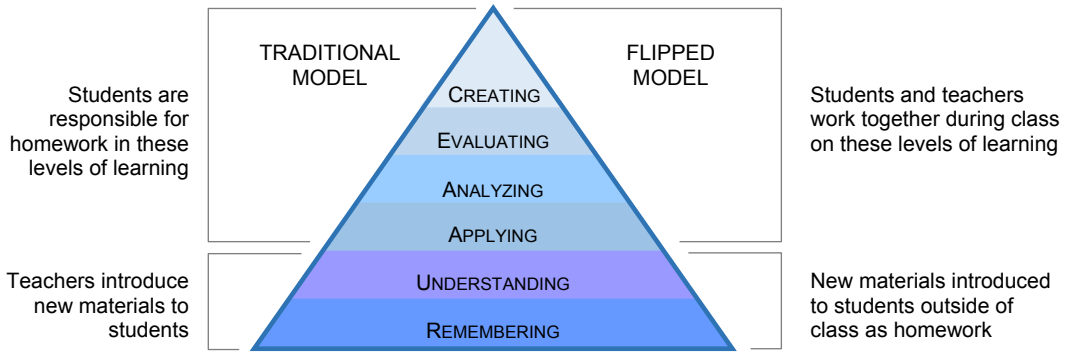

Figure 1. Bloom’s Taxonomy for Traditional Model vs. Flipped Model

Proponents of flipped classroom offered many benefits of flipped classroom, which reported on better student academic attainment, retention, etc. It is our argument that all the above are outcomes is not unique to the flipped classroom approach; rather it is an outcome that can be expected from any good pedagogic design, especially when it is applied in the context of today's learners in a technologically advanced, rapid-changing world. In fact, we tend to concur with Kim et al (2014) who reasoned that perhaps the most compelling reason is the need to adapt to the learning needs of today's students, often referred to as millennials – individuals born between 1982 and 2002 (Oblinger, 2003; Wilson & Gerber, 2008). This generation is distinguished by their access to technological and collaborative experiences. Characteristics of millennial students include 24/7 information connectedness, preference for environments that support multi-tasking, authentic learning experiences, and gravitation toward group activity and appreciation of the social aspects of learning (McMahon & Pospisil, 2005). They also demonstrated the need for instant gratification and low tolerance for delay, especially for long lectures. For a long time, there had been questions from educators and educational researchers on the effectiveness of teaching methods that are entirely lecture-based (Barr & Tagg, 1995). Numerous writers had called for a move beyond the lecture by employing methods that are more active, cooperative, and learner-centered (e.g. Bonwell & Eison 1991; Felder & Brent 2009; Lambert & McCombs 1998). However, as noted by Bligh (2000), despite innovations in technology enabling alternative techniques for pedagogy and continued criticism, the lecture method continue to be the primary method for teaching. He argues that they are as effective, but not more effective, as any other teaching method in transmitting information, and "are ineffective in stimulating higher order thinking". Ritchhart, Church, & Morrison (2011) noted that educators and researchers have come to recognize the "complexities of teaching and learning for understanding as opposed to just knowledge retention".

Flipped classroom, with its main focus on active learning in the classroom, is useful in addressing these challenges. Standard 8 "Active Learning" in the CDIO Standard noted: "Active learning methods engage students directly in thinking and problem solving activities. There is less emphasis on passive transmission of information, and more on engaging students in manipulating, applying, analyzing, and evaluating ideas…. Active learning is considered experiential when students take on roles that simulate professional engineering practice, for example, design-implement projects, simulations, and case studies". The flipped classroom also fits well with the rationale for Standard 8, which is worth repeating here: "By engaging students in thinking about concepts, particularly new ideas, and requiring them to make an overt response, students not only learn more, they recognize for themselves what and how they learn. This process helps to increase students' motivation to achieve program learning outcomes and form habits of lifelong learning. With active learning methods, instructors can help students make connections among key concepts and facilitate the application of this knowledge to new settings".

Despite the increasing popularity of flipped classroom, not every educator is comfortable with the approach. Shimamoto (2012) noted that though simple enough to understand, flipped classrooms are not quite as simple to implement due the range of technical skills, conceptual knowledge, and pedagogical expertise required to execute varying aspects of the method. Newton & Hes (2013) cautioned that if ill implemented, flipped classroom can throw up unexpected repercussions across the subject content and delivery. Some educators may obviously lack the skill – or more accurately, courage – to try their hands on flipped classroom. Some may still hold rigidly to the belief that students should be responsible for their own learning to the extent that they ought to be able to figure out for themselves how to

learn. Some may not be comfortable in the “role change” from one of “purveyor of knowledge” to one of coaching students in their learning.

More importantly is the issue of educator who may have mistaken notion of flipped classroom, for example, by simply make a video-recording of his/her lessons and continue to teach the same way when in classroom. Garrison & Kanuka (2004) paraphrased Marshall McLuhan as saying “it is not enough to deliver old content in a new medium”. Ash (2013), in writing about the benefits and drawbacks of flipped classroom, quoted Andrew Miller, an educational consultant who works with the Alexandria, Virginia-based professional development group ASCD and the Novato, California-based Buck Institute of Education, as saying “My concern is that if you're still relying on lecture as your primary mode of getting content across, …you haven't done anything to shift the type of learning that's occurring... Just because you flipped your classroom doesn't mean your students will watch the videos". Ramsey Musallam, from Sacred Heart Cathedral Preparatory, a private Catholic high school in San Francisco, agreed and noted that “what you're looking at is simply a time-shifting tool that is grounded in the same didactic, lecture-based philosophy. It's really a better version of a bad thing." (Ash, 2013). Agreeing, Bull, Ferster & Kjellstrom (2012) noted that “the effectiveness of this approach depends on the skill and pedagogical strategies you use. You can't magically transform an ineffective lecture by transferring it to video”.

These findings may not be that surprising – as in any new pedagogical approaches, few educators have direct experience with it, and early adopters are largely rely on their own experience to guide the process, learning what does and doesn’t work well for them (Crews & Butterfield, 2014). In their review of flipped classroom implementation, O'Flaherty & Phillips (2015) highlighted that the key obstacle of faculty in designing, implementing and evaluating the effectiveness of their flipped classrooms is a lack of pedagogical understanding of how to effectively translate the flipped classroom concept into practice. Hamdan et al (2013) argued that teachers do recognise the value of using sound pedagogical approaches to enhance the student experiences through curriculum renewal, but need support to develop skills needed to effectively guide the systematic use of technologies and translate conceptual thinking into planned learning sequences.

THE NEED FOR PEDAGOGY FOR FLIPPED CLASSROOM

There is henceforth a strong need to establish a pedagogically sound approach to implement flipped classroom. Although various authors agreed that there is no one way for classroom flipping (e.g. O'Flaherty & Phillips, 2015; Jarvis et al, 2014; Tucker, 2012), we felt that this is inconsequential – more importantly is the understanding of what flipped classroom entails. The important feature of flipped classrooms is not that they are new, or that they represent a move away from traditional lectures, or even that they use technologies. Rather, the issue is that flipped classroom approaches combine pedagogy and learning technologies in ways that extend to large numbers of students’ opportunities for deep learning through application and consolidation (Sankey & Hunt, 2014).

Several authors (e.g. Brame, 2013; Kim et al, 2014; Reyna, Davila & Huber, 2016) offered suggestions for successful implementation of flipped classroom. However, mostly of them are guidelines, lacking the systematic approach grounded in theoretical considerations. Few attempts had been reported, which include: (1) Oste et al (2014) who proposed using the design science approach of Peffers et al (2006) and Briggs’ (2006) theory-driven design approach to design a flipped classroom for the their information system classes; (2) Green

(2015) who used grounded theory (Glaser & Strauss, 1967) and Gerstein's (2012) 4-phase model of flipped learning to developed a framework for implementing flipped classroom in marketing education; and (3) Kelly & Barrette (2015) who proposed the FLICS (Flipped Learning-Centred Interactive Classroom Strategy) model based on the seven principles of good teaching and learning from Chickering & Gamson (1987) applied to Buemi's (2014) "microflips".

Added to this is the on-going debate on the effectiveness of flipped classroom. This issue will not be dealt with here (for more in-depth discussion, see Cheah & Sale, 2017). Suffice to note here is in recent years, there have been calls for education to follow other fields such as medicine and agriculture and embrace the use of evidence as a foundation for adoption of programs and practices (Slavin, 2008). Grocica & Buskist (2011) defined EBT as "the conscientious, explicit, and judicious integration of best available research on teaching technique and expertise within the context of student, teacher, department, college, university, and community characteristics." In EBT, evidence is used to: (1) in a diagnostic capacity improve the focus of our teaching, (2) in a motivation capacity to focus students' attention on their strengths and weaknesses, (3) as a means of program assessment to improve programming and planning, and (4) as a means of communicating student achievement to report on an assessment (Bruniges, 2005).

In the next section we present our own framework on the pedagogy for evidence-based flipped classroom. It is derived from an extensive synthesis of a wide range of knowledge bases relating to human learning by the first author, resulting in a set of key heuristics or core principles of learning, which, and together with high effect size intervention approaches (Marzano, 2007; Hattie, 2009; Petty, 2009), underpin highly effective teaching, and forms the basis of our framework for evidence-based flipped classroom. And satisfies the criteria of great pedagogy suggested by Husband & Pearce (2012). The pedagogic framework permits teaching professionals to thoughtfully plan learning experiences from a more evidence-based perspective in a wide-range of educational contexts (Sale, 2015).

PEDAGOGICAL FRAMEWORK FOR EVIDENCE-BASED FLIPPED CLASSROOM

The development of our framework is based on the following broad heuristics for effective and efficient teaching and learning approach (Sale, 2015):

1. Good learning design is *always* grounded on evidence-based practice, incorporating Core Principles of Learning
2. Information-communication technologies are used *strategically* and *creatively* to enhance specific aspects of the learning process
3. The completed blended learning design *maximizes* the affordances of a range of learning modes and mediums

Sale's Core Principles of Learning (Sale, 2015) cover the following:

1. Motivational strategies are incorporated into the design of learning experiences
2. Learning goals, objectives and proficiency expectations are clearly visible to learners
3. Learners prior knowledge is activated and connected to new learning
4. Content is organized around key concepts and principles that are fundamental to understanding the structure of a subject

5. Good thinking promotes the building of understanding
6. Instructional methods and presentation mediums engage the range of human of senses
7. Learning design takes into account the working of memory systems
8. The development of expertise requires deliberate practice
9. A psychological climate is created which is both success-orientated and fun
10. Assessment practices are integrated into the learning design to promote desired learning outcomes and provide quality feedback

In addition to incorporating all of the above features, our flipped learning framework also explicitly integrated the high effect size instructional strategies (Hattie, 2009) as well as the use of educational technology tools (EduTech tools) to not only facilitate student learning both online and in the classroom, but also to evaluate the effectiveness of the flipped classroom implementation by focusing on faculty reflection and student feedback on their learning experience. Our framework is shown in Figure 2. The outermost ring is the ultimate aim of teaching: to engage students in their learning. The next ring shows the use of core principles of learning in the design of learning tasks, with emphasis on use of EBT and sustained effort at continual improvement via course evaluation and lecturer's personal reflection. The next circle highlights learning designs that promote learning in both the pre-class or online (or out-of-class) and in-class components: the use of high effect size strategies (Hattie, 2009), collaboration between learners set in contexts that mimic real-world scenarios, to create content by collaborating with other fellow students. The learning process is supported by effective facilitation and timely feedback from the lecturer. The next inner circle shows 2 important factors that affect the support the learning in flipped classroom: the learning environment and use of EduTech tools. Lastly, note that our framework does not claim to be exhaustive or summative as new knowledge and insights will continually enhance our understanding of human learning and the implications of how we teach and how students learn.

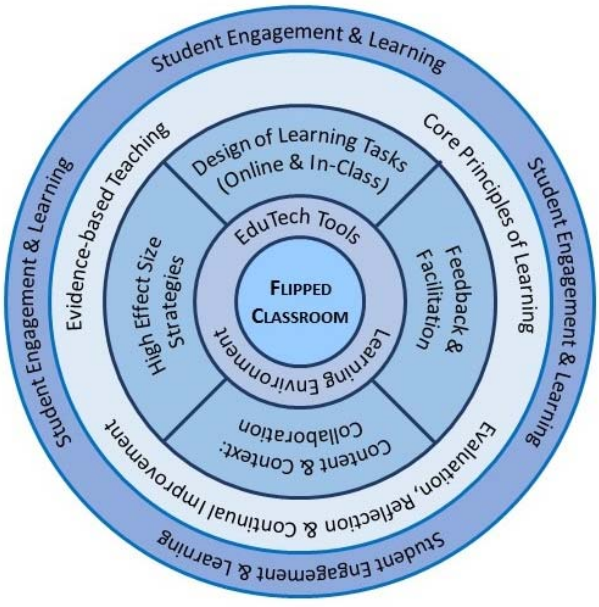

Figure 2. Framework for Evidence-based Flipped Classroom

DESIGNING AN EVIDENCE-BASED FLIPPED CLASSROOM

The design of any flipped classroom and its associated learning tasks should be constructively aligned (Biggs, 2003). Application of the core principles of learning permits the attainment of the required constructive alignment that facilitated learning. Furthermore, while each core principle focuses attention on a key area or process relating to how humans learn and the specific implication for design of learning tasks, they are not discreet or separate in that they should be considered independently of each other. They are in fact, mutually supporting, inter-dependent and potentially highly synergistic (Sale, 2015).

The design of flipped classroom should always stay focus on the learning tasks that we want students to do in classroom. This should have a clear focus of learning objectives to be achieved, including the level of proficiency to be attained (Principle No.2). This can be done by giving careful considerations to specific learning outcomes as often detailed in module syllabi, using Bloom's taxonomy for example. The learning objectives should be based on key concepts and principles necessary for students to obtain a good grasp of the subject matter to be mastered (Principle No.4). The learning tasks should not be overwhelming (e.g. too many concepts, too much factual information, too abstract, etc) that it taxed the learner's cognitive ability to make sense of what is being covered. This entails a good understanding of how our memory works, in particular the working memory (Principle No.7). One good way to achieve this is via "chunking" (Miller, 1956), or the splitting of content into manageable sizes, to facilitate the assimilation of information in the working memory. Even more effectively, some of these smaller "chunks" are based on some prior knowledge that students already acquired from other modules. Subsequent "chunks" of new information to be learnt are then skilfully weaved into the learning task so that new learning will result (Principle No. 3). More importantly, in the context of encouraging students to prepare themselves before coming to class, the learning tasks must be interesting enough that they are willing to invest time in going through them. This is especially true for the online component of flipped classroom, which need to be more than just postings of video recordings of the usual lectures. As such, motivational strategies must be incorporated into the design of learning tasks (Principle No.1). Effective and creative use of EduTech tools (more to be discussed below) can be a way to increase students' motivations.

Having designed the learning tasks, next comes the delivery of learning tasks. Here it is worth repeating the learning goals, objectives and proficiency expectations to the students (Principle No.2). It is imperative that instructional methods and presentation mediums engage the range of human of senses (Principle No.6). Also very important is the role played by the learning environment, where it is recommended by Principle No.9 that a positive psychological climate is to be created so as to promote student participation, both online and in-class. Sale (2015) offered the strategy based on SHAPE – Stories, Humor, Activities, Presentation Style and Examples – for creating desirable learning environment. In addition, the approach of "chunking" and building on prior knowledge also serve to build up students' confidence in learning the subject. This is especially useful for fostering collaborative learning among students. This approach also facilitates students' thinking process (Principle No.5).

Lastly, in terms of evaluating student learning, Principle No.10 emphasized the use of quality feedback to students as formative assessment. These, coupled with clear expectation of learning outcomes (Principle No.2), deliberate practice (Principle No.8) and conducive learning climate (Principle No.9) serve to motivate students to take responsibility for monitoring their own learning.

All the above can be supported by appropriate use of EduTech tools. In the context of this paper, EduTech tools refer to the freely available Web 2.0 Tools as well as specialized computer simulation and modelling softwares for use in teaching and in enhancing student learning. Although the above-mentioned core principles of learning did not make explicit references to use of info-communication technologies (ICTs) in general or EduTech in particular, their use is particularly noticeable in several core principles. For example, in Principle No.10 for facilitating the assessment process, EduTech tools immensely useful in delivering constructive feedback to students, often in real-time. EduTech tools can certainly be used to create learning materials that can engage a range of human senses. Helping students make connections to prior knowledge (Principle No.3) can be achieved via web site links to earlier topics. Similarly, elaborate topics can be divided into smaller segments and delivered via manageable "chucks" and integrated via hyperlinks. EduTech can also support Principle No.9 by including in the learning process elements of play, for example time-sensitive online quizzes. EduTech tools can also be used to promote good thinking (Principle No.5) but as noted by Sale (2014), we need to be clear from a pedagogical point of view about the types of thinking that we are trying to promote and provide practice in, as technologies themselves do not ensure good thinking.

It is important to note, however, that right from the beginning, we are very mindful to put "pedagogy before technology" (Watson, 2001). As noted by Schneider et al (2013), learning from educational technology is beneficial when the technology is designed as a function of the target content and built on a strong foundation in relevant learning theories. Likewise, Ascough (2002) asserted that "the use of technology should be driven by sound pedagogical principles. Sound pedagogy is essential to the effectiveness of all our teaching, no matter what the content or mode of delivery."

An example of how the above framework is used for implementing flipped classroom for a core module in a Diploma in Chemical Engineering is illustrated in a separate paper (Cheah, Sale & Lee, 2017).

DISCUSSIONS

Flipped classroom is still a relatively new phenomenon in today's educational arena. Tucker (2012) cautioned: "Given education's long history of fascination with new instructional approaches that are later abandoned, there's a real danger that flipping, a seemingly simple idea that is profound in practice, may be reduced into the latest educational fad. And, in today's highly polarized political environment, it also runs the risk of being falsely pigeonholed into one of education's many false dichotomies, such as the age-old pedagogical debate between content knowledge and skills acquisition."

Flipping a classroom is a continuous process and must be investigated as such to determine variables related to student learning and the flipped classroom approach including the content itself, the age level of the students, the technology and methods used to implement the approach (Connor, Newman & Deyoe, 2013). As noted by Newton & Hes (2013), the transformation of teaching to that of a flipped is a change that requires strategic alignment of many factors including space, pedagogy, assessment, IT infrastructure and student expectations. Although much had been learnt about it, much more remains to be explored, for example, the impact of learning environment, students' intrinsic motivation, promoting out-

of-class collaboration in the online component, etc are some of the areas worthy of future educational research. `

The design of flipped classroom concerns determining what curriculum components and specific learning outcomes can be effectively and efficiently met in the online environment, and what can be better facilitated in a face-to-face context, i.e. the "balance of the blend" (Sale, 2015). Being a relatively new teaching approach, there are some unanswered questions on flipped classroom. Weimer (2014) coined the word "flippant" attitudes about flipped classroom and raise the following concerns:

- Who should be taking flipped classes – first year students or seniors?
- Does the content of some courses flip more successfully than content in other courses?
- What criteria do we use when deciding what content to flip?

A review by Cheah & Sale (2017) showed that many diverse fields of study had adopted flipped classrooms. There are authors who opined that the flipped model "likely does not work in all contexts" (e.g. Crews & Butterfield, 2014; Yarbro, et al, 2014). And there are also those who suggested adopting some form of "partial" flipped approach (e.g. James, et al, 2014; Swift & Wilkins, 2014), which may include "flippable moment" (Honeycutt, 2014). However, as noted by Garrison & Kanuka (2004), the real indicator of effective blended learning is not the amount of face-to-face or online learning, but their effective integration within a programme to deliver meaningful learning experiences. This is supported by the work of Ginns & Ellis (2007) that drawn from a large body of seminal research, which asserted that the approaches students taken to learning, and the subsequent quality of their learning, is closely related to their perceptions of their learning experience. It is therefore our assertion that if the design process as outlined above has been appropriately negotiated, this issue is really only a matter of practicality and creativity.

CONCLUSION

In this paper we have presented a framework that we believe is useful to guide any lecturer who wants to embark on the flipped classroom journey. We have used the above framework (Figure 2) to design an evidence-based flipped classroom for a core module in the Diploma in Chemical Engineering. Details of the work done are presented elsewhere (Cheah, Sale & Lee, 2017). We have also conducted an evaluation of the flipped classroom the findings of which are also presented elsewhere (Cheah & Sale, 2017). We trust that our framework is a most comprehensive attempt to date to address the exciting, multi-faceted nature of flipped classroom using an evidence-based approach. It is useful not only in guiding lecturers interested in trying out flipped classroom, but also for those who are carrying out education research in the efficacy of flipped classroom.

As noted by Miller (2012), flipped classroom is only a start: "The focus should be on teacher practice, then tools and structures. The flipped classroom is one way to help move teachers toward better teaching but does not ensure it." He noted that while it may be true that learning is today's context is still largely dictated by the needs for examinations, and that materials learnt today will be useful when one graduated, these reasons do not engage the students who are already struggling to find meaning and relevance in school. If the flipped classroom is truly to become innovative, then it must be paired with transparent and/or embedded reason to know the content (Miller, 2012). This clearly points to the need for more research in flipped classroom.

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