# On the role of self-regulation in college-level mathematics classes

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**Abstract**

This paper is a small meta-analysis of studies in mathematics education, consisting of largely two sections: a section consisting of an indexed, annotated bibliography and another on a case study. In particular, this paper focuses on understanding the role self-regulation plays in mathematics classrooms at a college or university level setting. The annotated bibliography is composed of most relevant studies conducted in the last two decades or so. An index of keywords and pertinent quotes have been highlighted for the ease of the reader. The case study is conducted in an introductory linear algebra class at a liberal arts college and is meant to provide a small example into how self-regulation affects the learning.

## 1 Preface

### 1.1 Motivation

I politely ask you to consider: a typical child grows up being told over and over again to "be quiet" and to learn the materials presented in front of them; there are no stupid questions as long as they are relevant to the material at hand. As they progress into higher education (if they do), they find themselves often sitting in a large lecture hall, questions left unanswered "in the interest of time," and wondering whether the lecturer knows their name, or even cares if they show up at all.

A Google search for "changing higher education" returns a lot of articles responding to recent student strikes advocating for change in policies regarding finances and other economic concerns. In contrast, a search for "changing K-12 education" returns a 20-page ERIC (Education Resources Information Center) document on curriculum reform and effect on entering post-secondary institutions. It is not hard to find more evidence on how little classroom instruction has changed in a typical college in the last five to ten decades, if not more. With an increasing number of individuals pursuing a higher education, it seems naive to think that the current systems of education are still suitable or equitable to all students.

### 1.2 Definition

This paper is intended to highlight how ~~a particular aspect of education, namely,~~ self-regulation ~~takes~~ plays a role in college-level mathematics classes. In addition to ~~explaining the reasoning behind such specificity~~, below are some definitions to clarify the scope of this meta-analysis.

#### 1.2.1 Self-regulation

Using the definition provided by Zeider, Pintrich and Boekaerts' *Handbook of Self-Regulation*:

> Self-regulation refers to self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals.

Adopting a focus on self-generation of thoughts and actions that are expected to lead to attaining personal goals is in particular a statement of power. The power dynamics of a traditional classroom setting is the centralized "monarch" conducting a group of powerless individuals on their actions and knowledge.

## 2 Annotated bibliography

## References

Benjamin O. Abakpa and Clement O. Iji. "Effect of mastery learning approach on senior secondary school students' achievement in geometry". In: *Journal of the Science Teachers Association of Nigeria* 46.1 (2011), pp. 165–177.

Annotations: Study conducted on students in a secondary school mathematics course on geometry. Quantitative results show massive improvements after mastery learning methods. Gender differences were also analyzed, but there was no significant differences in achievement between male and female students with mastery learning approaches.

Laura Ariovich and Sadé A. Walker. "Assessing Course Redesign: The Case of Developmental Math". en. In: *Research & Practice in Assessment* 9 (2014), pp. 45–57. ISSN: 2161-4210. URL: `https://eric.ed.gov/?id=EJ1062722` (visited on 02/09/2018).

Annotations: This study uses modular (mastery based) curriculum with the assistance of computer software. The problems that arose included computer software issues, but were not restricted to those. The workload of the class was far heavier than traditional settings, which students showed dissatisfaction for.

Benjamin S. Bloom. "Learning for Mastery. Instruction and Curriculum. Regional Education Laboratory for the Carolinas and Virginia, Topical Papers and Reprints, Number 1". en. In: *Evaluation Comment* 1.2 (May 1968). URL: https://eric.ed.gov/?id=ED053419 (visited on 02/15/2018).

Annotations: This is one of Benjamin Bloom's original and first papers officially on the subject of learning for mastery (LFM). The paper begins with the current problems that exist in the status quo method of instruction, in particular regarding the use of the normal curve in assessment. Bloom discusses variables that determine "mastery" in students: aptitude, quality of instruction as well as ability to understand instruction, perseverance and the time allowed for learning. This paper broadly describes the ways in which learning for mastery can be incorporated into the classroom setting, and shows a little bit of evidence of the success of LFM.

Kirk Bradley. "Evaluating the effects of mastery learning in postsecondary developmental mathematics". PhD thesis. US: ProQuest Information & Learning, 2017.

Kwok-cheung Cheung, Soi-kei Mak, and Pou-seong Sit. "Resolving the attitude–achievement paradox based on anchoring vignettes: evidences from the PISA 2012 mathematics study". en. In: *Asia Pacific Education Review* (Mar. 2018), pp. 1–11. ISSN: 1598-1037, 1876-407X. DOI: 10.1007/s12564-018-9526-9. URL: https://link-springer-com.ccl.idm.oclc.org/article/10.1007/s12564-018-9526-9 (visited on 03/17/2018).

Annotations: This short paper looks into the paradox between attitude and assessment in students' mathematics performance across various countries in East Asia. There is little discussion of why the paradox may exist, and discusses more about a new way to identify the paradox.

Carlton J. Fong and Jaimie M. Krause. "Lost Confidence and Potential: A Mixed Methods Study of Underachieving College Students' Sources of Self-Efficacy". In: *Social Psychology of Education: An International Journal* 17.2 (June 2014), pp. 249–268. ISSN: 1381-2890. URL: http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1039527&site=ehost-live&scope=site (visited on 02/19/2018).

Annotations: This study looks at the differences of self-efficacy between underachieving and achieving groups of students. Results showed no statistically significant differences. Factors that may have led to this result include the fact that underachievers received more positive, verbal feedback. Furthermore, the study pointed toward mastery learning experiences as one of the more influential reasons that boosted self-efficacy in the underachievers. One caveat of this study is that they students are coming from a relatively high-achieving university, so self-efficacy could likely have carried over from past experiences in high school.

Andju Sara Labuhn, Barry J. Zimmerman, and Marcus Hasselhorn. "Enhancing students' self-regulation and mathematics performance: the influence of feedback and self-evaluative standards". en. In: *Metacognition and Learning* 5.2 (Aug. 2010), pp. 173–194. ISSN: 1556-1623, 1556-1631. DOI: 10.1007/s11409-010-9056-2. URL: https://link-springer-com.ccl.idm.oclc.org/article/10.1007/s11409-010-9056-2 (visited on 03/02/2018).

Annotations: This study looks at a particular self-evaluative methods that take into account individual versus social comparative feedback playing a role in improving self-efficacy. Predicted results would be that receiving individual feedback that is not affected by competition factors would do better to improve self-efficacy. Actual results showed that students who received individual feedback were actually the most dissatisfied with their performance. Possible reasons included the fact that social comparative feedback gives context to what are realistic and achievable goals that motivate both over-confident students and well-achieving students to have a more solid grasp of what is expected in their performance.

Laurie Lenz. "Active Learning in a Math for Liberal Arts Classroom". In: *PRIMUS* 25.3 (Jan. 2015), pp. 279–296. ISSN: 1051-1970.

*Self-Regulation: A Characteristic and a Goal of Mathematics Education - Handbook of Self-Regulation - Chapter 21.* URL: https://www.sciencedirect.com/science/article/pii/B9780121098902500500 (visited on 03/02/2018).

Annotations: This chapter is a thorough overview of self-regulation in the context of mathematics, and is probably the best starting read to understand the scope of self-regulation in mathematics, in particular in the classroom setting. Multiple intervention studies are taken into consideration and analyzed, and subjects of the studies are varied in demographics. Common successful components were identified and significant evidence suggested that fostering self-regulation skills were possible. The sort of self regulation implemented in classrooms were more related to problem solving skills than self-regulated assessment.

File: Self-Regulation\:ACharacteristicandaGoalofMathematicsEducation-HandbookofSelf-Regulation-Chapter21:/Users/jennylee/Zotero/storage/LQW7TNCU/B9780121098902500500.html:text/html.

Rebecca A. Simon et al. "Exploring Student Persistence in STEM Programs: A Motivational Model". In: *Canadian Journal of Education* 38.1 (Jan. 2015). URL: http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1057949&site=ehost-live&scope=site (visited on 02/19/2018).

Annotations: The study looks particularly into the effects of supporting student autonomy in order to increase the feeling of self-efficacy. In particular, it looks into STEM fields and differences in gender. Results showed that the effects were more visible and positive in male students, but not so much in female students.

In addition, the study confirms that a mastery based approach was beneficial to developing intrinsic motivation, despite lower performance.

Wenlan Wang et al. "Environment Matters: Exploring the Relationships between the Classroom Environment and College Students' Affect in Mathematics Learning in China". In: *Asia Pacific Education Review* 18.3 (Sept. 2017), pp. 321–333. ISSN: 1598-1037.

Steven Zollinger. "The Impact of an Online, Mastery, and Project-Based Developmental Math Curriculum on Student Achievement and Attitude". In: *Walden Dissertations and Doctoral Studies* (Jan. 2017). URL: `http://scholarworks.waldenu.edu/dissertations/4120`.

Annotations: This is a detailed literature review and research conduced on online, mastery and project based learning, specifically in mathematics in college level classrooms. Research needs for each learning style are outlined. In particular for mastery based learning, qualitative research is needed, in particular because of contradictory results on student stress levels and engagement. Research questions explored quantitative data on content knowledge as well as qualitative input on things like student attitude.

# 3 The case study