Examining the relationship between self-reflection and academic achievement in problem-based learning

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Abstract— **Problem-based learning (PBL) has been an essential pedagogical strategy in teaching and learning Architectural Design since the early days of the discipline. As with any pedagogical strategy, multiple factors impact the learning outcomes in a PBL-based classroom. Among them, 'reflection' features frequently in the literature. This essay examines the relationship between reflection or more specifically, self-reflection and academic achievement in PBL. The examination is based on Reflective essays written by the students at the end of the semester. Reflective Essays are correlated with academic achievement in the subject of architectural design. The essay concludes that there is a strong correlation between self-reflection and academic achievement.**

***Keywords*— Architecture; Design; Problem Based Learning (PBL); Self-Reflection.**

***JEET Category*—Practice**

I. Introduction

DESIGN studio occupies a central position in the predominant pedagogical model of teaching architects. Lawson in his design expertise identified five features of a design studio (Lawson & Dorst, 2009). First, a studio is a place where students and teachers are in the same space for a long time. Second, the studio has a lot of unstructured time with some scheduled activities like 'crits' (short for 'criticism'). Third, the design studio is a place where students integrate learning from various other subjects like construction and structure. Fourth, in the studio, students learn by doing. The teachers set design problems for the students which the students solve. The idea behind this approach is to mimic the real-world practice of architecture, which is the fifth distinguishing feature of a design studio as argued by Lawson.

As a learning strategy design studios make use of problem-based learning (PBL) in general and pedagogy of creative problem solving in particular. The design studio lacks a rigid schedule and definite content to be 'taught'. This results in shifting the responsibility of learning in the studio onto the student. In other words, the design student must 'self-regulate' her design learning. Zimmerman has explained self-regulated learning as a three-stage cyclical phase process (Zimmerman & Moylan, 2009). The three stages are planning the learning or forethought, performing the task and third that of self-reflection.

The solutions to the design problem that students work on are assessed formatively (during the semester) as well as through a summative assessment (at the end of the semester). These assessments are primarily 'performance' oriented. Meaning, that the students are marked for the work that they produce and not for the processes that lead to the product. Such assessment does not assess either the forethought or the self-reflective phase of learning.

Both the stages, that of 'forethought' and 'self-reflection', have not received much attention in the context of architectural design education. The present essay focuses on self-reflection and examines whether the performance assessment of a problem-based design learning studio is correlated to student reflection

II. Literature Review

Design studio pedagogy aims to take students on a path toward design expertise (Lawson & Dorst, 2009). To explain design learning, Lawson drew upon Dreyfuss's model of expertise and adapted it to design learning. Dreyfuss's model postulated that expertise acquisition goes through stages of development beginning from that of a novice, beginner, advanced beginner, competent, expert, master and finally visionary. Lawson further elaborated that the design student's transition between these stages is interrupted by 'dips and leaps-and-bounds' (Lawson & Dorst, 2009, p. 242). These transitions as Lawson says require reflection on part of the student designer (Lawson & Dorst, 2009, p. 216). A typical design studio assesses performance through a series of developmental performances and the final performance through the design portfolio. However as discussed above, mere performance is an incomplete pedagogical goal.

A more explicit connection between design learning and self-regulation was articulated by Powers (2017). Based on the PBL model as discussed by Savery (Savery & Duffy, 1996), Powers named four key elements of a design studio. These are

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– 1. the studio, 2. Design problem, 3. Design teachers, and 4. Design learners. Powers states that for learning to happen, the students must be active participants and be able to regulate their learning. Powers further argues that while the first three of these elements receive adequate attention, the element of self-regulation receives the least attention although it is a critical component of problem-based learning.

Self-regulation as postulated by Zimmerman in his cyclical phase model consists of three iterative stages. These are, Forethought, Performance and Self-Reflection. An elaborated version of the cyclical phase model of self-regulation was published in 2009 (Zimmerman & Moylan). In this model, Zimmerman further elaborated on self-reflection as having two distinct aspects self-judgement and self-reaction. Self-judgement was discussed as having two further aspects namely self-evaluation and causal attribution. Self-evaluation is where the learner compares her performance with a standard. Causal attribution is where the student assigns causes like lack of ability, effort, time management etc. to her performance. As per Zimmerman, both evaluation and attribution are interdependent concepts. The second category of the self-reflection phase is self-reaction, which in turn is composed of self-satisfaction and adaptive/defensive decisions. Students prefer activities that produce satisfaction and avoid learning that leads to negative emotions. Adaptive decisions lead to choosing certain strategies of learning while defensive decisions may consist of procrastination, apathy etc. This activity of self-reflection cyclically affects the forethought phase on the path to gaining expertise. It, therefore, is a critical component of the self-regulated learning process.

In the field of design, the concept of self-reflection was extensively written about by Donald Schön (1982). Arguing a strong case for the role that reflection plays in education, Schön distinguished between two types of reflective practice. One is what he calls 'reflection-in-action' and the second; is 'reflection-on-action'. 'Reflection-in-action' happens during the act itself. In Zimmerman's terms, it is the reflection that happens during the phase of performance. According to Schön this type of reflection is only subtly different from 'knowing-in-action'. Reflection in action has immediate significance for the task at hand. While 'reflection-in-action' is difficult to observe distinctly, what is relatively easier is to reflect on the 'reflection-in-action'. As Schön says reflection-on-action can directly affect our future action or the forethought phase of Zimmerman's model.

There have been many studies that relate self-reflection to academic achievement. These studies examine diverse student categories including high school students, students of occupational therapy, applied science and dental medicine students. A study by Lew (Lew & Schmidt, 2011) concluded that while there are positive effects of self-reflection they may not be measurable by academic test achievement. Even though the subjects were enrolled in a course which was organized based on problem-based learning, the authors state that although the ability of the students to self-reflect improved during the semester, there was no improvement in the test scores. A 2016 study from Iran (Ghanizadeh) examined 196 university students and concluded that self-reflection positively and significantly affected academic achievement. Cavilla's study of high school students found a statistically insignificant correlation between academic performance and self-reflection (2017). A 2019 study of dental students found that there is a significant correlation between reflection and academic achievement (Loka, Doshi, Kulkarni, Baldava, & Adepu).

It appears that although there is an assumption that students who are better at self-reflection demonstrate better academic achievement, the actual research findings are divided. At best the research suggests a causal relationship at one end while on the other end the studies acknowledge the positive impact of self-reflection but do not support a causal relationship between self-reflection and academic achievement. However, there are not many studies that attempt to establish a correlation between academic achievement and self-reflection in the domain of architectural design discipline.

III. Purpose of the Study

There is little research on self-reflection in the context of architectural design education. I aim to examine the relationship between academic achievement and self-reflection. Along with this I also aim to understand intrapersonal factors that may contribute to academic achievement. Considering the qualitative and quantitative nature of the study, I use statistical analysis along with qualitative content analysis.

RQ 1 - Is there a relationship between academic achievement and the self-reflection skills that a student has?
RQ2 – What aspects do students consider important to design learning?

The findings may help educators in problem-based learning settings to improve student learning

IV. Methodology

A. Context

The study was conducted at a third-year design studio at a school of architecture located in Pune. The yearlong activity consisted of two courses Architectural Design IV and Architectural Design V. Out of a total of 56 credits of the year, these two courses account for 20 credits. 30% of weekly teaching time is allotted to the course. By its nature, the subject of design seeks integration and application of various other subjects. The faculty set up design problems for the students to work on. Architectural design course depends heavily on interaction between students and faculty as well as amongst students.

B. Participants

Forty students were part of the study. All the participants were female. Out of these fifteen participated in the voluntary writing of the reflective essay at the end of the year. The students were tutored by four facilitators as a team. As all participants were female, the study does not examine the impact of gender on the outcome.

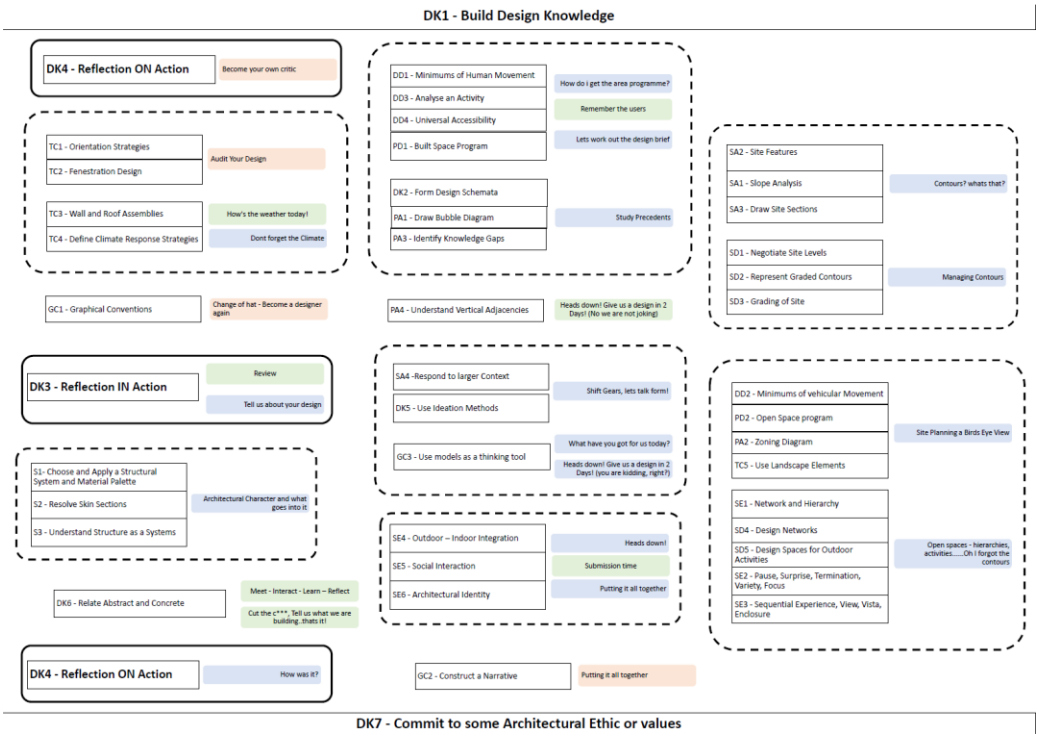

Fig.1. Graphic Syllabus which was shared with the students at the beginning of the Studio. The Syllabus mentioned the acts of reflection-in-action and reflection-on-action.

C. Measures for Quantitative Analysis

1) Academic achievement

The design portfolios produced by the students were assessed during the semester and at the end of the semester as per the University system through an oral examination. These marks consist of 50% marks given by the internal examiner and 50% marks given by the external examiner at the end of the semester assessment. An average score for both the semester-end exams was used for the study.

2) Self-reflection

For reflection-in-action, we (Studio Facilitators) relied on the critical incidence questionnaire (CIQ) developed by Brookfield (2017). This questionnaire was filled by students on a weekly or fortnightly basis by the students. However, the CIQ feedback was collected anonymously. It was not possible to correlate it with individual academic achievement and therefore has not been considered in the analysis.

The reflection-on-action component was requested from students as a voluntary submission. The students were asked to write letters to their juniors who would be joining the same studio after them. The studio team decided to ask for such a 'letter to your junior' rather than a specific reflective essay about self; for two reasons. First, research shows that self-reflection is a fraught task. As Malkki (2010) reports, an individual's natural tendency to maintain 'pre-existing structures' is a fundamental barrier to self-reflection. Self-reflection involves challenging self-assumptions which is problematic for the comfort zone that individual wishes to occupy. Externalizing the self-reflection in the form of a letter to someone else attempts to remove this barrier to self-reflection. Second, Nilson (2013) suggested that 'letters to the next cohort' as an assignment is more useful to the outgoing students because the assignment makes them reflect on 'where they slacked off and what it cost them, where they pushed themselves and how they benefited, how wisely they directed and monitored their studying, how diligently they planned and developed their assignments, and how effectively they budgeted their time during the term.'

The concepts of reflection-in-action and reflection-on-action were introduced to the students through a graphic syllabus (Fig 1). The graphic syllabus highlighted the role of reflective thinking about the expected studio learning. Other than the inclusion of the idea of reflection in the graphic representation of the syllabus, there was no attempt to introduce reflective thinking as a skill.

D. Data Collection and Quantitative Analysis

The data about academic achievement was collected from the exam results. The marks received for Design IV and Design V were averaged to a percentage value. At the end of the year, the students were asked to write a 'letter to their junior' who would be joining the studio in the coming year. As a studio facilitator team, we avoided giving the students a structure or a questionnaire for the writing of the letter. It was felt that doing so would bias the students in a particular way of thinking reflectively. Writing the essay was a voluntary submission and was not a marked assignment. The studio strength was 40, of which 15 students wrote the reflective essay titled 'letter to my junior'. The letters were coded, and themes were identified. The initial coding was compared to

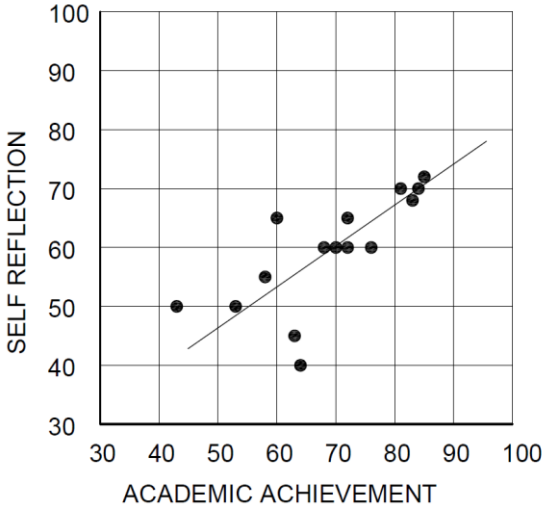

Fig. 2. Scatter plot of self-reflection scores and academic achievement

themes of self-reflection identified from Zimmerman's description of the self-reflection phase.

An evaluation checklist was prepared based on the categories (Table 1). The essays were marked out of 100 based on the checklist. To improve the reliability of the evaluation, two independent assessors were asked to blind-mark the essays based on the evaluation tool. A per cent agreement between the scores was calculated to be 74%.

A graph of the academic achievement (marks received at the end of semesters 5 and 6) and Self-reflection (Evaluated essay) was drawn as a scatter plot (Fig. 2). The plot showed a high degree of correlation between the two variables. Pearson's coefficient of correlation was calculated for the data which came to be 0.739, corroborating the scatter plot conclusion.

E. Method for Qualitative Analysis

The quantitative analysis led to answering of RQ 1 which investigated the relationship between academic achievement and self-reflection skills. A qualitative or inductive content analysis was done for the data to examine RQ 2 which was aimed at probing the aspects important for design learning.

Inductive content analysis is a qualitative method of analysis (Vears, 2022). This method is used to code data without using any preconceived categories. The essays were read multiple times and coding was done in an iterative manner until a saturation point was reached.

F. Qualitative or Inductive Content Analysis

The essays were coded for terms which were not covered in the evaluation check list prepared for the quantitative analysis. This analysis revealed various categories in an inductive manner. For something to be identified as a category, a criterion of 20% occurrence was used. For a sample size of 15 that the present study used, an occurrence of the concept in 3 or more essays was considered and analyzed. No grading was done based on frequency of occurrence as the sample size was deemed to be small for such an analysis.

TABLE I
CHECKLIST FOR EVALUATING THE SELF-REFLECTIVE ESSAYS

Evaluation checklist for self-reflection essays

Dear Assessor

Kindly assess the student reflective essays based on the following checklist. There are five aspects that you may use to evaluate the essay. Mark the essays out of 100. The marks allotted to each characteristic are indicated in bracket. The third column briefly describes the characteristics on the list.

Your assessment may be based on the characteristics mentioned, however please don't be limited by the list mentioned. The list is given as a guide for what to look for in the essays (letter to my junior)

Criteria	Marks	What to look for
Self-evaluation	25	Is the learner comparing her performance with a standard? Is there a mention of individual goal setting?
Causal Attribution	25	Is the student assigning causes to her performance? (Negative - lack of ability, lack of time, laziness) (Positive – inspiration, role models, classroom environment, faculty)
Self-Satisfaction	25	Is the student expressing satisfaction, happiness, sense of learning, progressing, achievement?
Adaptive Decisions	12.5	Are there any recommendations for learning strategies such as – time management, interacting, asking questions, learning new skills…
Defensive Decisions	12.5	Is there regret of certain decisions that did not work such as – losing track of time, aiming for perfection, not being regular, not understanding the overall picture, loosing opportunities to stay with the class…

These identified categories were labelled based on theoretical constructs from literature on Pedagogy. Subsequently, the categories were grouped under three broad themes: first, habits such as time management, second, attitude towards learning (performance orientation versus enjoying the work) and third, about the learning process (realizing importance of scaffolding and asking questions for learning).

V. RESULTS

A. Quantitative Findings

The scatter plot and Pearson's coefficient show a high level of correlation between the two variables of academic achievement and self-reflection. The students whose academic achievements are high have correspondingly high self-reflection scores.

Following is a list of illustrative quotes from the essays. These quotes are a sample of the criteria considered in the quantitative evaluation of the reflective essays –

1) Self-evaluation

Examples of goal setting and evaluating oneself against a standard.

"You are your own competition. Keep beating (sic) yourself and you shall succeed"

"It (setting goals) was a bit difficult approach to me, but I suggest you should give it a try"

2) Causal Attribution

These are examples of both negative and positive causes that students wrote about as causes of their academic achievement or lack thereof.

"Looking at other people's work always inspires me"
"Don't repeat the same mistake which I did of being lazy"

3) Self-Satisfaction

Feelings of happiness and sense of learning as expressed by students.

"Be focused on your work and enjoy the design process"
"I can say that I have learnt the most from doing case studies to design ideation, from overall design development to designing the smallest details"

4) Adaptive /defensive decisions

Students expressed regret about some of the decisions that they felt should have been made during the semester.

"Explore new presentation techniques"
"Please be regular with your work, it is very important"
"Speak up, talk about your design, ask questions about others' designs"
"Learn to communicate your thoughts and concepts through your design"

B. Qualitative Findings

While doing a content analysis of the essays, certain themes were found to be recurring. The themes along with example quotes from the essays are listed below

1) Time management

The importance of managing time was a frequently observed theme.

"Please be regular with your work"
"submit your work on time"

2) Enjoying work

Neuroscience recognizes that we have a 'pleasure brain'. Having fun and learning are closely related (Bain, 2012). The students who recorded enjoying the learning also scored better on self-reflection.

"Enjoy your journey"
"Enjoy this process of learning"
"I hope you will also enjoy it"

3) Scaffolding

As a technique of learning scaffolding was proposed by Vygotsky (Langford, 2005). As compared to learning by 'discovery'; scaffolding has an element of teaching intended in the concept. It is a stage-wise learning process that is supported by teachers.

"*Doing stage-wise design as per the schedule is the most important thing*"
'*we first learn the alphabets (sic), we are not worried about how to write a paragraph*"

4) Questioning / Discussing / Commenting

Asking a question in the classroom (Browne & Keely, 2007) and discussing (Brookfield & Preskill, 1999) have been considered important tools for a learner-centred classroom. Having a classroom atmosphere that promotes questioning and discussing would be a desirable goal of any teacher

"*Don't be afraid to ask questions*"
"*Always remember to speak up, raise your queries and opinions*"
"*Speak up, ask questions*"
"*Discuss your work regularly*"

5) Performance Orientation

The phrases quoted below, indicate that the students are more focused on performance in the final assessment rather than their learning. Research (Bain, 2012) indicates that students who have learning orientation are deep learners as compared to surface learners who focus just on getting good grades.

"*They* (the faculty) *like sketches"*
"*They* (the faculty) *have a lot of knowledge, so surely make a smart use of it"*
"*do the small exercises neatly"*

It is likely that the data from the 15 essays may not have been able to uncover a comprehensive set of aspects that students consider to be important for design learning. A larger data set collected over successive years will more likely reveal a comprehensive set of aspects. However, the analysis presented in this essay indicates the potential of self-reflective student essays in revealing aspects important for design learning.

VI. Conclusion

A strong correlation between 'self-reflection' and 'academic achievement' suggests that incorporating 'reflection-on-action' activities as part of the classroom may be beneficial for student learning. The second part, that of 'reflection-in-action' may be encouraged by encouraging the maintenance of a reflective journal.

Most of the themes as revealed by qualitative analysis (time management, scaffolding, questioning and discussing) are skills that can be incorporated into problem-based learning. The teachers may actively make these a part of the session plans. Lastly, the study provides teachers with a potential tool to improve student learning.

VII. Limitations

A follow-up study of the students during their remaining two years at the institute is likely to reveal whether the correlation between academic achievement and the habit of self-reflection continued in their senior years. The role played by the classroom practices of the faculty and the design studio environment has not been accounted for in the study.

VIII. Implication

Problem-based learning strategy is an established pedagogical tool. It is widely used in the teaching of architectural design. The practice of critical reflection through the writing of an 'end of semester' reflective essay can

complement the pedagogical practice and positively impact academic achievement.

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