AC 2008-1414: STIMULATING AND DEVELOPING REFLECTIVE THINKING IN UNDERGRADUATE STUDENTS

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Stimulating and Developing Reflective Thinking
In Undergraduate Students

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Abstract – One of the most important goals of higher education is to teach students how to develop original solutions to complex problems, and to remain open to revising their decisions based upon future good evidence. The ability to do this has been referred to by researchers such as King and Kitchener[1] as Reflective Judgment or Reflective Thinking. At Illinois Institute of Technology, a midsize, private Midwestern university, we are attempting to give the students on our undergraduate, multidisciplinary project teams a stronger base in good decision-making skills through the development of Reflective Thinking. During the Fall 2006 and Spring 2007 semesters, a subset of these students (N = 96 and 102, respectively) completed 3 written assignments per semester that each contained one or two Reflective Thinking questions. Responses to these questions were coded into 3 levels of Reflective Thinking based on the Reflective Judgment Model (RJM) developed by King and Kitchener.[1] We also introduced several interventions during the Spring 2007 semester that were intended to promote Reflective Thinking in our students, and comparisons between Reflective Thinking scores from the Fall 2006 and Spring 2007 semesters suggest that these interventions may have made a difference, although the difference was statistically significant only for the third Reflection, for which there was an average Reflective Thinking level of 1.26 for the Fall of 2006, compared to an average Reflective Thinking level of 1.73 for Spring 2007 ($p < .01$). Possible factors contributing to the observed differences, as well as other implications of the results and directions for future changes, are discussed.

Introduction

In higher education, one common, all-encompassing goal is to teach students the skills they will need to make good decisions in the real world. However, it is often unclear to educators whether they are meeting this goal for their students or not.

In line with this goal, King and Kitchener[1] have defined and studied the concept of Reflective Judgment, which we refer to here by using the equivalent term "Reflective Thinking." Reflective Thinking is defined as the ability to make good decisions about ill-structured problems, or problems that do not have simple, clear right answers. This is clearly a crucial skill, as many of the problems that students will encounter in the real world will indeed be ill-structured.

King and Kitchener [1] developed the Reflective Judgment Model (RJM), a seven-stage framework describing the development of Reflective Thinking. These seven stages were also grouped into three broader categories: pre-reflective thinking, quasi-reflective thinking, and reflective thinking. Within this framework, pre-reflective thinking generally reflects a belief that all problems are well-structured, and that the "correct" answer to every problem can be obtained from experts or authority figures. Quasi-reflective thinking reflects some advancement away from this belief and the beginning of the ability to recognize that some problems are ill-structured and that collecting and evaluating evidence is a part of the knowing process. Still, when confronted with an ill-structured problem, quasi-reflective thinkers tend to either claim that

they are unable to make a decision, or to make a decision and subsequently select evidence that supports that decision, rather than making an integrated conclusion based on all of the evidence that is available.

The most advanced stage, reflective thinking, is characterized mainly by, 1) the belief that some problems are ill-structured and cannot ever be solved with absolute certainty, 2) the ability to critically evaluate the quality and coherence of available evidence to work toward an integrated understanding of a problem, and 3) an understanding that decisions about ill-structured problems need to be reevaluated as time passes and the pool of available evidence changes.[2]

King and Kitchener's RJM[1] is very similar to an earlier framework for intellectual and ethical development during the college years that was defined by William G. Perry, Jr.[3] on the basis of a longitudinal study conducting interviews with a sample of undergraduate college students. Although over the years of this study, Perry did observe a good deal of development in the students he interviewed, overall his observations are consistent with those observed by King and Kitchener and suggest that most college students do not reach very mature levels of complex problem-solving ability before they graduate. King and Kitchener[4] specifically observed that most undergraduate college students demonstrated characteristics of pre-reflective thinking, although some advanced undergraduates had progressed to the quasi-reflective level. The highest level, reflective thinking, was usually observed only in advanced doctoral or post-doctoral students.

Our Program and Sample

At IIT, undergraduate students from every discipline are required to participate in at least two one-semester, three credit-hour multidisciplinary project team courses. In these courses, students are required to work together with students from other majors to develop a solution to a real-world problem. Each semester, approximately 300-400 students are enrolled in 30-40 different multidisciplinary team project courses, usually with about 10-12 students on a single team.

Student majors at IIT include, among others, various subdisciplines of engineering, architecture, psychology, mathematics, computer science, and various disciplines within the physical and biological sciences. The topics covered by the multidisciplinary project team courses are also widely varied, and often a single project topic calls for expertise from several different disciplines.

The students in the current sample are a non-random subset of students taking multidisciplinary project team courses during the Fall 2006 and Spring 2007 semesters. Participation in this research project was optional, and the faculty instructors who were leading the teams self-selected to participate on behalf of the teams. Faculty instructors were recruited by employees of the university academic department responsible for coordinating the multidisciplinary project courses. Since students tend to enroll in these courses during their junior and senior years, most of the students in this sample are college juniors and seniors.

Reflections

The typical "gold standard" for measuring Reflective Thinking is a one-to-two hour structured interview, known as the Reflective Judgment Interview .[1] This method of measuring Reflective Thinking was not feasible for our purposes, so we have developed a set of questions based on King and Kitchener's research. These questions are included in written assignments called Reflections (more recently called "Individual Reports") which include questions about the students' general experience in the team and about progress on the project as well. Students' written responses to these questions are coded into one of three levels of Reflective Thinking, based on the RJM. Each student response is scored as either pre-reflective (1), quasi-reflective (2), or reflective (3).

During the Fall 2006 semester, 96 students on 11 different multidisciplinary project teams completed three Reflections assignments roughly at the beginning, middle, and end of the semester. Each Reflection assignment included seven to ten questions, and the three questions used in the current analysis were:

> **The Solution Question: Included on Reflection One, Question Six**
> "Is there more than one way to solve the problem your [team] faces? What are other possible solutions? How do you know which one is best? Can you ever be completely sure that solution is the one that should be implemented?"

> **The Ethics Question: Included on Reflection Three, Question Three**
> "What other possible solutions are there to the ethical problem? Which solution to the ethical problem do you think is best and why? How confident are you in the solution? Include the method used to resolve the differences of opinion and the level of agreement on your final assessment."

> This question was preceded by the question, "Ethical issues in [multidisciplinary project teams] are of two types: those involving behaviors within the [team] and those involving the eventual application of [team] output to the larger society. Please outline the most important ethical problems the team has encountered over the entire semester. What was the issue and what was the outcome? From your experience(s) this semester please explain the best course of action the team could or should have taken to produce the optimal resolution to its ethical dilemma. How did you contribute? If you did not contribute, how could you have contributed? "

> **The Importance Question: Included on Reflection Three, Question Eight**
> "Has your view of the importance of [this project] changed since the beginning of the semester? Has your view of the benefits to the community and society outside of [this university] of [this project] changed since the beginning of the semester? Why or why not? What might be the counter argument to your view of the overall importance of [this project] (i.e. [this project] has no importance outside of [this university])? Can you be sure either opinion is correct? How or why not?

During the Spring 2007 semester, 102 students on 12 different multidisciplinary project teams completed three Reflections assignments, also roughly at the beginning, middle, and end of the

semester. Each Reflection assignment included seven to thirteen questions, and the questions used in this analysis were:

The Solution Question: Included on Reflection One, Question Six

"Is there more than one way to solve the problem your [team] faces? What are other possible solutions? How do you know which one is best? Can you ever be completely sure that solution is the one that should be implemented?"

This question is exactly the same as the form of the question that was used during the Fall 2006 semester.

The Ethics Question: Included on Reflection Two, Question Three

"From your experience(s) this semester please explain the best course of action the team could or should have taken to produce the optimal resolution to its ethical dilemma. What other possible solutions are there to the ethical problem? Which solution to the ethical problem do you think is best and why? How confident are you in the solution? Include the method used to resolve the differences of opinion and the level of agreement on your final assessment."

This question is similar, but not identical to the form of the question that was used during the Fall 2006 semester. It was preceded by the question, "Ethical issues in [multidisciplinary project teams] are of two types: those involving behaviors within the [team] and those involving the eventual application of [team] output to the larger society. Please outline the most important ethical problems the team has encountered over the entire semester. What was the issue and what was the outcome?"

The Importance Question: Included on Reflection Three, Question Four

"Has your view of the importance of [this project] changed since the beginning of the semester? Why did it change? Has your view of the benefits to the community and society outside of [this university] of this [project] changed since the beginning of the semester? Why or why not? What might be the counter argument to your view of the overall importance of [this project] (i.e. [this project] has no importance outside of [this university])? Can you be sure either argument is correct? How or why not?"

This question is similar, but not identical to the form of the question that was used during the Fall 2006 semester.

Summary of Changes Made Between Fall 2006 and Spring 2007 Semesters

Several of the significant changes made between the Fall 2006 and Spring 2007 semesters had to do with the timing of the Reflections assignments and the order of presentation of the different Reflective Thinking questions across the three assignments.

The first set of changes to the Reflections process all had to do with the timing of the Reflections assignments throughout the academic term. First, the timing of the three Reflections was adjusted slightly. During the Fall 2006 semester, Reflections were completed at roughly weeks 4,

8, and 12 of the 16-week semester. During the Spring 2007 semester, the due date for the first Reflection was adjusted from week 4 to week 5, so that it coincided with the completion of team project plans. This was because it had been noted by team instructors that many students were unable to effectively answer questions about their projects until after they had at least started to write a specific plan for the work they were going to do. Second, the timing of the second Reflection was changed to week 9, or the week after the students' spring break, to allow the students to use their break to complete the assignment. Also, the timing of the third Reflection was changed to week 15 or 16, so that students did not have to submit the final Reflection until after the end-of-semester projects day conference in which all the multidisciplinary project teams formally present the results of their work over the entire semester. This conference is a major culminating event for students in the program, so it was difficult for students to focus on any other assignments during the weeks leading up to it.

A second change to the Reflections process that was made for the Spring 2007 semester had more to do with the order of presentation of the specific Reflective Thinking questions. During the Fall 2006 semester, students tended to exert a very apparently smaller amount of effort on the third Reflection. As mentioned, the timing of the third Reflection during that semester was probably at odds with the students' need to focus on the end-of-semester projects day conference. However, even after adjusting the timing of the assignment for the Spring 2007 semester, the third Reflection still coincided with many other assignments and exams in students' other classes. The third Reflection originally included questions about ethical issues related to the students' projects, and the second Reflection included mostly questions about teamwork and communication within the project team. Considering that ethical issues are often ambiguous and complex, whereas issues with teamwork and communication tend to be somewhat less complex, it seemed that the ethics questions may be more beneficial in terms of stimulating Reflective Thinking. Therefore, it was decided that it would be better to ask the ethics questions on the second Reflection, so that they would receive more effort from the students and have the maximum possible benefit for them. Thus, the second and third Reflection from the Fall of 2006 were essentially switched in order for the Spring 2007 semester.

A third fairly significant change that was made to the Reflections process between the Fall 2006 and Spring 2007 semesters was the inclusion in the second Reflection of a description of "open-ended problems" (equivalent to ill-structured problems) and the techniques for analyzing and solving open-ended problems, taken from Lynch and Wolcott's paper "Helping Your Students Develop Critical Thinking Skills".[5] Following this description of open-ended problems and tips for understanding and solving open-ended problems, students were asked nine questions based on the RJI.[1] These questions asked the student to 1) identify an open-ended problem that he or she had encountered during their work on the project that semester, and 2) use the information provided to analyze the problem and to identify, analyze, and defend a good or "best" solution to that problem.

The fourth and final notable change that was made for the Spring 2007 semester was that all teams that were participating in the Reflections process received an introductory briefing before completing the first Reflection. These briefings included, 1) the reasons why the students were being asked to complete the Reflections, such as the benefits the assignments could have for the individual and the team, 2) a description of the stages of Reflective Thinking and the way the

assignments would be used to measure this construct, and 3) an explanation for students that although the completion of the Reflections assignments was required by their instructor, participation in the research project was entirely voluntary, and the students could opt not to give their consent if they did not want their responses to be used for the purpose of educational research.

Comparison of Fall 2006 and Spring 2007 Reflective Thinking Scores

The average Spring 2007 Reflective Thinking scores were higher than the average Fall 2006 Reflective Thinking scores for all three of the questions used in this analysis: Solutions, Ethics, and Importance. However, this difference was significant only for the Importance question.

For the Solutions question, the average score for Fall 2006 was 1.68, while the average score for Spring 2007 was 1.75 ($p = 0.42$). For the Ethics question, the average score for Fall 2006 was 1.35, while the average score for Spring 2007 was 1.52 ($p = 0.08$).

For the Importance question, the average score for Fall 2006 was 1.26, while the average score for Spring 2007 was 1.73 ($p < 0.01$).

Discussion and Future Directions

There are several factors that may have contributed to the observed differences between the average Reflective Thinking levels observed during the Fall 2006 semester and the average Reflective Thinking levels observed during the Spring 2007 semester. As detailed above, several interventions were introduced during the Spring 2007 semester with the intent of stimulating higher levels of Reflective Thinking. The interventions are one possible source of the observed difference. It is particularly notable that the largest difference between the two semesters was on the Importance question, which during both semesters was included on the third Reflection. As mentioned, one change that was introduced during the Spring 2007 semester was the adjustment of the deadline for the third Reflection so that it would no longer conflict with the teams' busiest day of the semester, and they would be more likely to exert some effort in completing it.

Of course, although there is some repeating of the same students between the two semesters, many of the students in these two samples are different. It is possible, although not likely, that the students who were enrolled in these courses during the Spring 2007 semester were simply more "reflective" than the students who were enrolled in the program during the Fall 2006 semester.

Additionally, a new rater was introduced at the end of the Spring 2007 semester and rated several late submissions of Reflection Three, so it is also possible that the new rater was more likely than the old rater to rate a response as "reflective," which would inflate the average Reflective Thinking scores. Evaluation of inter-rater agreement on a sample of previously rated Reflection Two assignments indicated that agreement between the new rater and the old rater ranged from fairly poor for the Importance question (Cohen's kappa = .29), to moderate for the open-ended question set not included in this analysis (Cohen's kappa = .56), to quite good for the Ethics question (Cohen's kappa = .76). Since agreement was poorest on the Importance question, this is

certainly a possible contributing factor; however, the ratings assigned by the new rater were not consistently higher than the ratings assigned by the old rater, so it is unclear whether this lack of agreement really would have inflated the average score very much.

Also, the problems with agreement between the two raters cannot explain the higher Reflective Thinking scores that were observed on the Solutions and Ethics questions, since during the Spring 2007 semester these questions were included on Reflections One and Two, which were rated before the new rater was introduced (a subset of responses to the Ethics question were later used to evaluate inter-rater reliability, but the averages presented here reflect only the original ratings assigned by the old rater).

Given the observed results, it seemed that it was advisable to continue with the timing of the Reflections that was used during the Spring 2007 semester, so we have kept that timeline in place since evaluating these results. We did not, however, continue with the introductory briefings or the inclusion of the open-ended problem set on the second Reflection. This was not because these interventions did not appear to be beneficial, but rather because not all teams participate in this project, and it was difficult to secure faculty participation in the project in time to plan these briefings effectively. Similarly, it was decided not to continue the open-ended problem set; not because students provided poor responses to those questions in comparison to the other Reflective Thinking questions. but rather because so many students provided feedback at the end of the semester saying that the Reflections included far too many questions and were too time-consuming to complete.

Although we have not continued these interventions, the Reflective Thinking scores from our Fall 2007 sample of 104 students indicate that, overall, we are still seeing higher levels of Reflective Thinking than we have in the past; the overall average across two Reflection assignments (reduced from the original three) was 1.97. The average Fall 2007 score on the Solutions question was 2.09, compared with 1.75 in Spring 2007; the average Fall 2007 score on the Ethics question was 1.61, compared with 1.52 in Spring 2007; and the average Fall 2007 score on the Importance question was 1.78, compared with 1.73 in Spring 2007. The difference in scores was not statistically significant for the Ethics or Importance question ($p = 0.48$ and 0.68, respectively), but it was statistically significant for the Solutions question ($p < 0.01$).

Part of this difference may be due to the interaction of the specific Reflective Thinking question asked with the content of the project in which the student is involved. For example, many of the level 3 or "reflective" responses that were observed during the Fall 2007 semester were in response to the Solutions question *and* came from students who were working on a project whose goal was developing affordable solutions for the world's rural poor. Intuitively, it makes sense that it may be easy for even a relatively immature student to understand that there is not only one way to attack an issue as nebulous as rural poverty. If the same student were working on a problem like designing an effective website for a company or solving problems in a heat treating furnace, he or she might be less likely to acknowledge that there are multiple valid approaches to the problem, because these problems tend to be at least somewhat "neater" and more clearly defined.

Also, the same student described above, even if working on the same very ill-structured problem, may be less likely to answer "reflectively" when asked questions about his or her ethical behavior choices or about the importance of the problem that his or her team is addressing. Indeed, this is exactly what was observed: students from this particular team tended to provide very reflective responses to the Solutions question, acknowledging that there were of course multiple ways to tackle such a complex problem, but were much less likely to acknowledge that there were multiple ways to behave ethically with regard to the rural poor; they were more likely to insist that there was a "right" or a "wrong" way to treat these people. They were also unlikely to provide reflective responses to the Importance question; they tended to respond to this question with very defensive answers, such as "I can't imagine why anyone would say that this problem is not important; we are helping the poor, and our project could save people's lives. I don't know why anyone would even try to make that argument" [paraphrased from several students' responses].

Aside from this observation, it is also possible that Reflective Thinking scores are somewhat higher for the Fall 2007 semester because of an ethical education intervention that started this semester. This intervention encouraged students to analyze ethical issues and principles of ethical behavior from multiple perspectives, which could theoretically help them to develop a cognitive framework that would support higher levels of Reflective Thinking. It is unclear whether this intervention contributed to the observed differences or not. Theoretically, the average score on the Ethics question should have been affected most by this intervention, and this average was not very different between the Spring 2007 and Fall 2007 semesters.

Our experiences over the last three semesters have provided us with ample information to advise our continued study into the development of Reflective Thinking in college students. In the coming semesters, we plan to continue the use of these assignments in a subset of our multidisciplinary project courses, as well as to continue the ethical awareness intervention that we piloted during the Fall 2007 semester. In order to preserve the maximum possible amount of consistency between the Fall 2007 and Spring 2008 semesters, we will continue to use the same three Reflective Thinking questions. We hope to gain a somewhat larger sample of students and analyze the results both at the school level and at the team level to gain some further insight into the effect that different project topics can have on the level of Reflective Thinking that students exhibit when they answer these questions.

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