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A REFLECTION ON THE EFFECT OF STEM COURSES ON STUDENTS PERFORMANCE

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Abstract: The STEM course CAMP060, integrating chemistry, arts, mathematics and physics, represents a strategic shift from the traditional paradigm of discrete preparatory courses. Students joining the engineering programs struggled in preparatory courses; the issues were primarily related to lack of student engagement, motivation, learning skills, adaptation, and discrepancy in expectations.

In the Spring of 2016, the CAMP060 course was initiated and piloted primarily to a group of students entering an engineering program to prepare them for their Freshmen courses. The course was designed as a developmental pre-calculus level course involving algebra, geometry, trigonometry, chemistry, and physics with an emphasis on their use in engineering. Simultaneously, the *arts* component was embedded in the course through stimulating and enhancing both communications and writing skills. The course delivered content using a hands-on-hybrid-flipped model with an emphasis on self-study, context rich problems solving, and study skills for university students.

The results were promising and showed a great potential for further experimentation and development. Students' performance in the individual subjects were remarkably comparable. Furthermore, the success rate in the subsequent level courses was notably higher as students exhibited higher maturity, responsibility, and academic persistence.

Keywords: Stem, camp060, engineering, student performance, adaptive learning system

Introduction

All students entering The Petroleum Institute (PI) must take a Placement Test in mathematics and chemistry to determine their appropriate level of mastery in Mathematics and Science. PI had been offering non-credit preparatory courses in mathematics and chemistry to help underprepared students to recall and master the foundation of the mentioned courses. Most students were placed in these preparatory courses. The preparatory mathematics course was a pre-requisite for the preparatory physics course. Therefore, the Placement Test did not evaluate students' knowledge levels of the physics content.

These preparatory courses were intended to help students develop the essential knowledge, skills and motivation needed to succeed in their subsequent courses. The effect of the preparatory courses on students' success and performance was to be measured by the performance of the students in the succeeding courses. The success rate in the upper level courses was unsatisfactory and students struggled in mathematics and science courses. In fact, research shows that programs addressing a substantial amount of content do not provide learners with a strong expertise in mathematics and science (Derzon, 2014).

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Another issue that created a flaw in the students' education path was that a student could finish all the mathematics requirements for the intended degree but still be taking a preparatory chemistry course or vice versa. Moreover, students faced major difficulties in preparatory physics course which was offered in the following semester. Thus, the flow chart of some students' courses or degree path created many gaps and ambiguities. Therefore, a solution was needed.

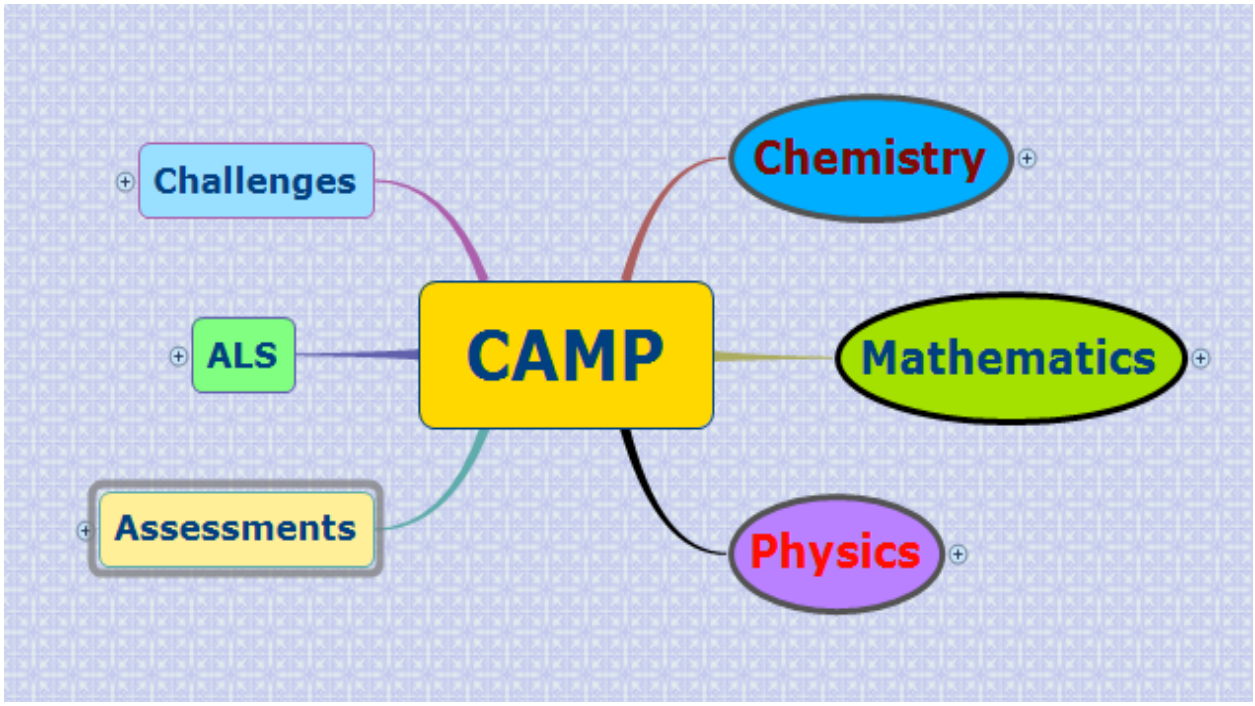
To overcome these complications, an integrated mathematics and science courses to real-life was recommended; a modified form of STEM (Gonzalez & **Kuenzi**, 2012). As a matter of fact, according to the progressive tradition of Dewey, student's engagement is optimal when content is related to real-life scenarios (Dewey, 1910).

Implementatıon and Results

Course Design

The PI vision was to create a STEM course in which its curriculum integrates concepts of the combined subjects without sacrificing the individual structures, complexity and rigor of mathematics and science. This approach resulted in creating an integrated course comprising chemistry, arts, mathematics and physics (CAMP060) (Figure 1).

Figure 1. CAMP060 course map and components



CAMP060 is a 12 credit course that focused not only on teaching the content but addressed thinking skills opportunities for practice. The new course was presented by one integrated syllabus where the Course Outcomes show the dynamic of presenting topics to minimize redundancy and integrated projects related to engineering and the energy industry, with relevant mathematics, science and communication knowledge and skill (Al-Holou et al., 1998). The difference between the CAMP060 and the preparatory courses in the PI lies in the unified curriculum and the learning approach offered to students by fostering thinking skills.

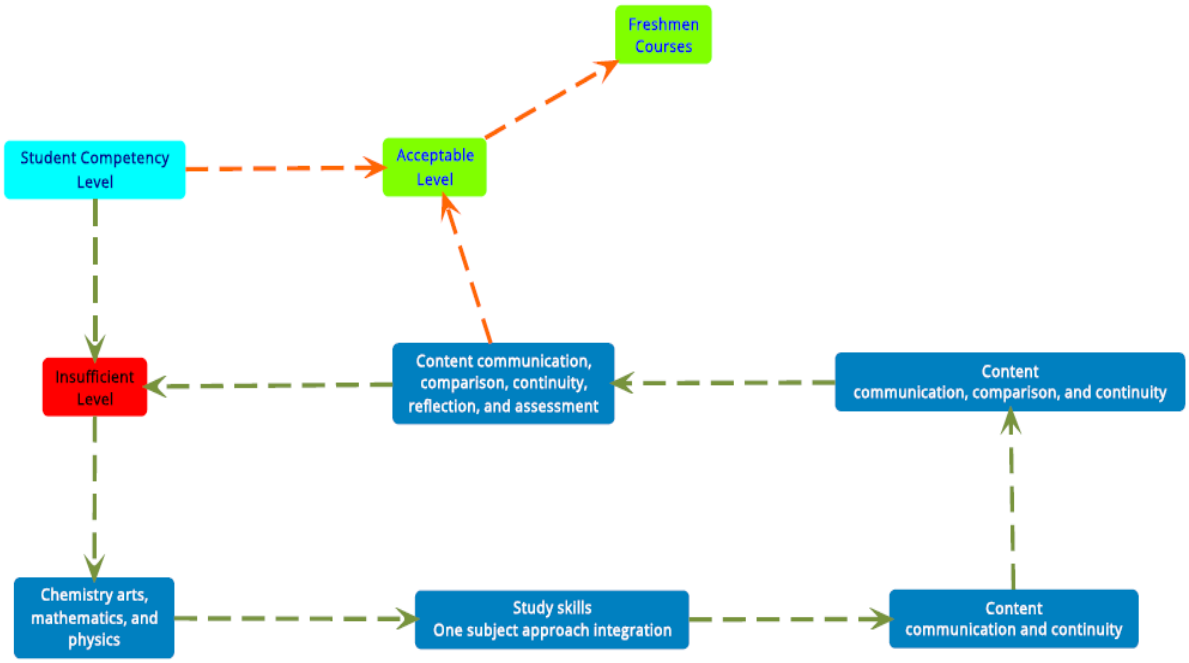
The curriculum encompassed student-centered learning that provided active learning experiences. This approach intended to convey the fundamental knowledge of mathematics and science needed while actively engaging and motivating students by using project-based and problem-based learning (Defeng, Chunling, &Yuanjian, 2015).

In addition, Adaptive Learning Systems (ALS) such as Aleks and WileyPlus enhanced students' learning and introduced students to independent learning approaches where they benefited from learning study skills and time management (**Weber, 1999)**.

Conceptual Framework

Students entering the PI must take a Placement Test (PT) to determine their appropriate level. Students who pass the PT are placed in Freshman Level I courses. Otherwise, they will be placed the CAMP060 (Figure 2).

Figure 2. Student college entrance placement cycle



Discussion

In the Spring of 2016, the PI piloted the CAMP060 course. Learning was offered through lectures, student collaboration and cooperation, hands-on experiments, independent learning using ALS and a group project. The variety of teaching and learning methods boosted students' engagement and motivation (Hativa & Lesold, 1991) which were clearly shown in the integrated group project.

Moreover, the use of ALS yielded an effective way of monitoring student performance and highlighting weakness areas. Initially, students took an initial check to gauge their competency level. A significant number of students scored low. When they were tested again upon completing of the assigned objectives on ALS, the scores were significantly higher.

The results were also supported by written final exams which showed a high correlation between their ALS grade and their final exam grade. Factors such as constant monitoring, alignment of vision and objectives, integration, authentic learning, motivation were instrumental to the substantial improvement throughout which was shown (Figure 3 and Figure 4).

Figure 3. Comparison of the midterm grades between the ıntegrated subjects

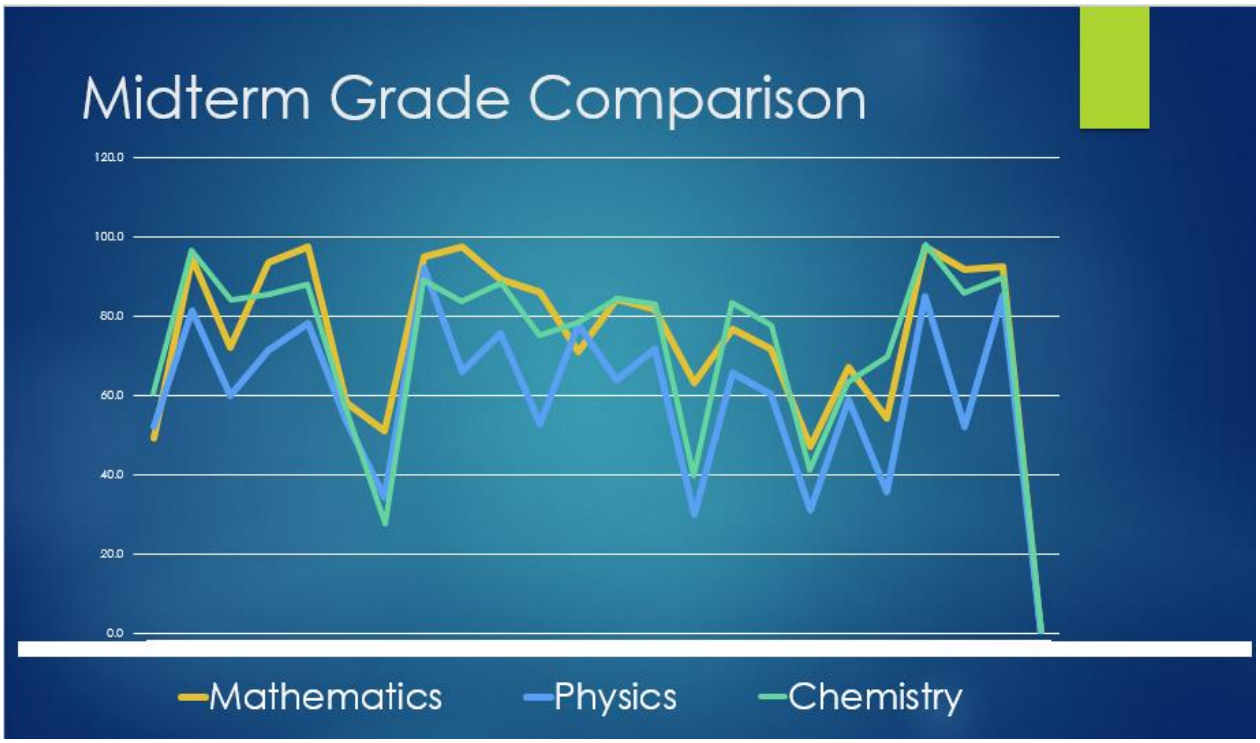
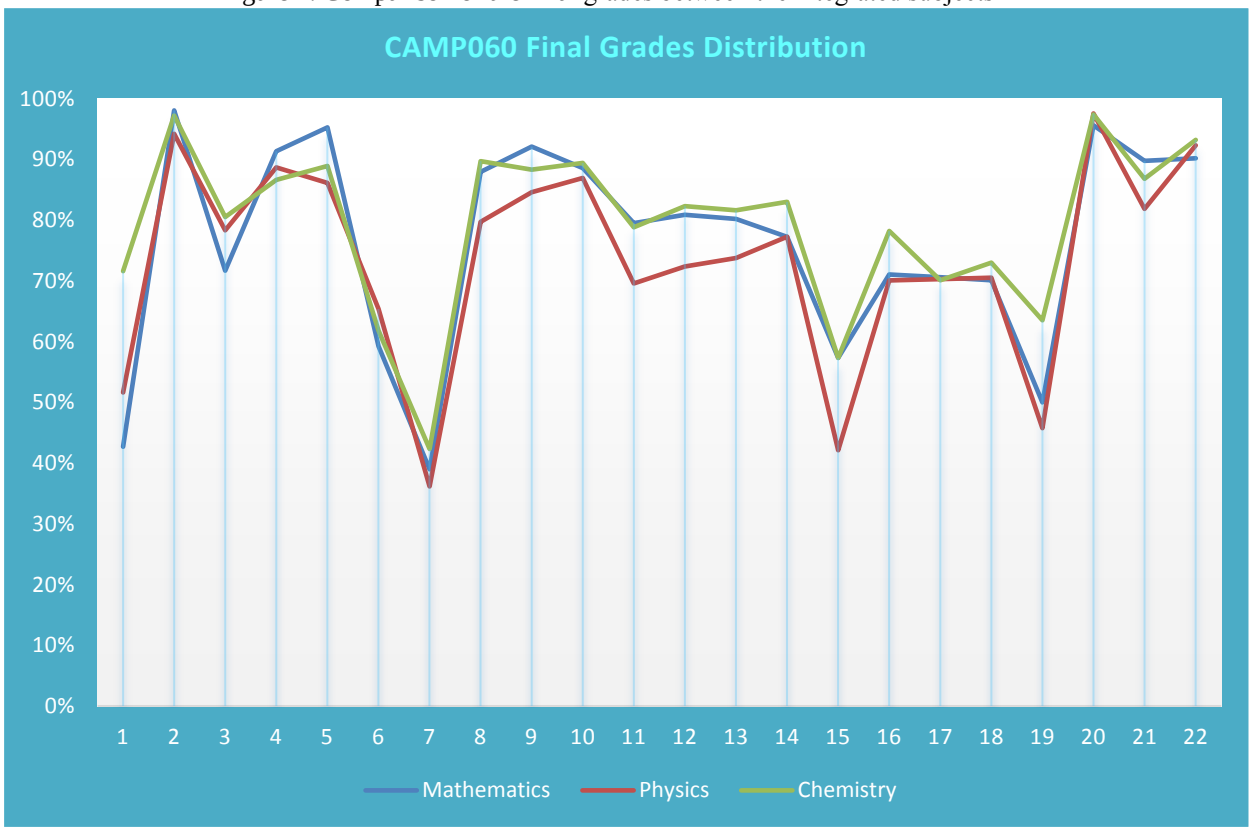


Figure 4. Comparison of the final grades between the ıntegrated subjects



Conclusion

The CAMP060 course design helped students gain better work strategies, such as prioritizing, multitasking, as well as study and test taking skills. Students improved at processing context-based questions over the course of the semester. The subjects' scores correlated with students' grades. Moreover, the final scores correlated with

final exit exam scores. The comparison between students' independent online learning and overall grades depicted the strong relationship between these two learning paths.

Nevertheless, the CAMP060 course overcame some of the challenges throughout the pilot period and highlighted for improvements. For instance, the mathematics content used in the CAMP060 course was pre-requisite for the physics. However, in the integrated course, they became co-requisites for the course which created some difficulties in the early stages for students to comprehend the physics components. Thus, the objective alignment for the CAMP060 course subjects was essential.

Overall, implementing the CAMP060 course represented an innovative shift in the PI students' academic path, learning styles, persistence, motivation and achievement.

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