

## **Early Alert & Intervention System in Early Math Courses for Engineering Students**

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### **Abstract**

The retention and graduation rates of undergraduate students, particularly in STEM fields are attracting significant attention nationwide. Several academic and non-academic factors can be barriers to student persistence or contribute to student retention and graduation. Many students admitted to the College of Engineering (COE) at the University of Nebraska-Lincoln (UNL) are underprepared and therefore experience challenges and need extra attention, coaching, and support to ensure they are successful and achieve their academic goals. Through the implementation of an Early Alert & Intervention System (EAIS), the institution, college, and academic units will be able to provide individualized support for students who may not persist without interventions. Personal contact from the COE retention coordinator and advisors provides a catalyst to positively impact the persistence and resilience of at-risk students. This paper provides a work-in-progress description of an EAIS process which was implemented in Spring 2022 for the Calculus I class required of all COE students. Results of this pilot study show promising improvements for future implementation in this course as well as other courses.

### **Keywords**

early alert, intervention, student success, engineering, mathematics

### **Introduction**

Student retention and graduation rates continue to provide reliable metrics for student success in higher education. Several factors contribute to some students' decision to withdraw from a degree program while other students may not graduate in a timely manner. These factors can be either academic or non-academic. The development and implementation of a retention program could prove to be an important effort provided by an institution, college, or an academic unit. Specifically, students in COE face a broad range of challenges not only during their first year, but also throughout the course of their degree program. The demanding nature of engineering curricula can push students to choose a different major in engineering, leave the college, or leave the institution. Alternatively, students may need longer time to complete their program requirements. According to a 2017 report [1] by the American Society of Engineering Education (ASEE), the 4-year and 6-year graduation rates in 2014 for white students was 33% and 60% respectively, while for Latino/Hispanic students the rates was 25% and 45%, and for African American students the rate was 20% and 38% respectively.

Noteworthy work on the topic of student retention and success was reported by Tinto and Cullen [2] and later by Astin [3]. They developed theories and practices on student engagement,

resilience, and persistence. The early alert programs (originally called early warning systems), however, were first developed by Astin [4]. Hensel, Sigler, and Lowry [5] implemented two calculus intervention approaches. One intervention strategy was investigation of a grade recovery program on students who earned a grade of D or F on the mid-term, and the other strategy was implemented during mid-terms for students who intended to withdraw from their calculus class. This was designed with the purpose of preparing students for taking calculus in the next term. The result of the first strategy helped 25% of students to receive at least a C grade in the course. The second strategy revealed that these students have an equal rate of succeeding in Calculus I on their next attempt. Another early alert system was implemented in a Mechanics of Materials course [6]. The model developed a method for detecting students at risk of failing and helping them plan proactive approaches to be successful. It also predicted the performance of the students with exceptional accuracy. In a 2021 study [7], a comparison of students who completed proactive intervention behavior modules revealed a significant correlation between the number of modules completed and the final grade obtained in the course.

The purpose of this paper is to investigate the potential impact of an Early Alert & Intervention System (EAIS) designed to address engagement, persistence, and resilience as well as awareness of student support services in the College of Engineering (COE). This involves (solicitation) or referral by campus members such as faculty to inform advisors about students in distress, early identification and targeting potential at-risk student (early alert), collaboration and cooperation of instructors and the professional advisors to understand their challenges both academic and non-academic (intervention), connect them to available resources (support) which are proactive and targeted remedial actions, and track their progress toward their success in a particular course or their major of study (feedback).

Examples of solicitation include pre-enrollment indicators and behaviors, notifying campus members to identify at-risk students, and notifying the advisors.

Examples of effective early alerts include attendance rates, results of a pre-test, response to survey, financial burden, content knowledge, non-academic issues that are the real barriers to their success, and sense of belonging to the college and the major.

Examples of effective intervention include simple notification of faculty communicating concerns about academic preparedness to advisors, student's behavior, lacking college readiness skills, getting to know their professors early in the semester, understanding the syllabus to see how their grade is calculated, notes on the graded assignments, Learning Management System (LMS) notes, among others.

Examples of support include academic support such as tutoring and academic resource centers, understanding the differences between high school and college, forming study groups, test taking strategies, time and self-management, non-academic support such as mentoring, dealing with anxiety and stress, goals and values affirmation, and accessing campus resources

Examples of feedback include tracking student's progress throughout the course and during the following semester, mentoring, goal setting, and action plans.

## Method and Process

The goal of this process is to help students develop academic skills, identify individual goals, get acclimated to the college environment, and connect them to resources. The intention is to act early in the semester before the student faces academic consequences. However, students will be identified at multiple points over their progress in the selected course(s). The COE retention and student success coordinator will be the main contact person. The proposed EAIS is shown in Figure 1. and consists of five steps.

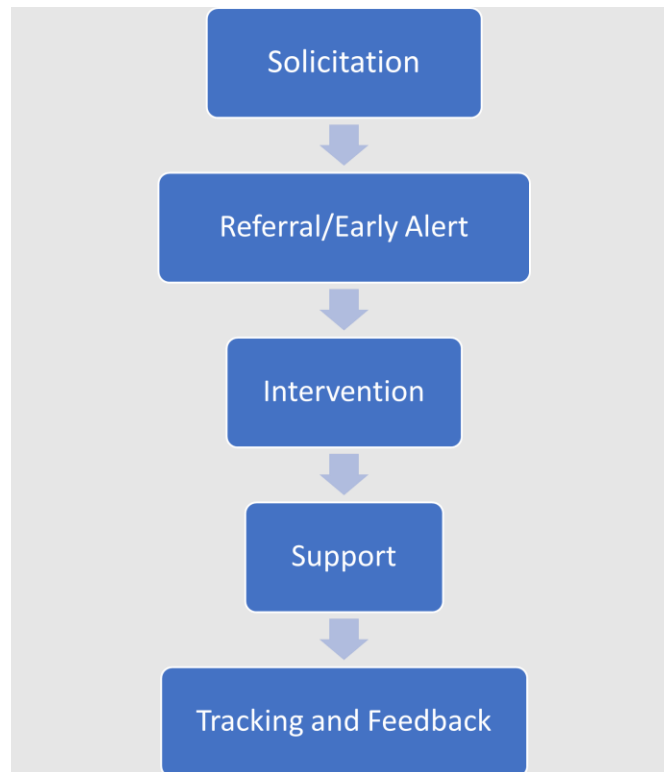


Figure 1. Proposed Early Alert and Intervention System

### Step 1. Solicitation

What about the results of pre-test administered by the college?

- Campus office, individual units, or course instructor identify students with at-risk behavior
- Canvas Analytics may identify students with at-risk behavior
- Faculty identify students with at-risk behavior

### Step 2. Referral/Early Alert

- Campus office, Canvas Analytics, or faculty communicates to EAIS coordinator with specific information about student during the first 3-4 weeks of the semester

Step 3. Intervention

- EAIS coordinator will contact student to address at-risk behavior.
- EAIS coordinator will meet with the student frequently to address the needs.

Step 4. Support

- EAIS coordinator in collaboration with instructor and advisor will provide adequate support to the student. More effort will be provided to students who need it the most.

Step 5. Tracking and Feedback

- EAIS coordinator will follow up with faculty to see if things are improving and whether or not faculty intervention is needed

**Results and Discussion**

Calculus I was selected for implementing EIAS in Spring 2022. This course is taught on two campuses (Lincoln and Omaha) where engineering programs are offered. For the purpose of this study, Steps 2 and 3 of the EAIS process were implemented in these courses.

A list of potential at-risk College of Engineering (COE) students enrolled in these Math courses were identified within the first two or three weeks of the spring semester.

Data from the Lincoln campus was based on the results of a pre-test called the Course Readiness Activity (CRA) [8] given during the first week of class (on paper) to all students taking Calculus I. Subsequent attempts were taken at the Digital Learning Center which provides proctored online exam services. This allows for several attempts over three weeks until they show proficiency. The purpose of this test is to help recover lost skills and complete mastery of pre-calculus concepts. It is reported that students who don't engage in the preparation required to pass the CRA are the students who typically fail the course. Students can move to a pre-calculus class if needed through the third week of classes without any penalty. An additional objective is to identify skill deficits early in the semester so that instructors can provide targeted help in areas of high need to improve success rates.

On the Omaha campus, students spent a week reviewing pre-requisite materials before a quiz over that content was administered. Students who scored below the designated threshold were then offered (and strongly encouraged) to participate in additional review and targeted remediation in Assessment and Learning in Knowledge Spaces (ALEKS), an online tutoring and assessment program [9]. Table 1. shows results of the CRA exam from the Fall 2021 semester, showing the need to support students in these courses who did not pass the CRA exam.

In the Spring 2022 semester, results of the CRA exam at the beginning of the semester were given to the retention and student success coordinator and an intervention was applied to students on both campuses. This intervention included an email notifying the student of their results and links to campus resources for success in math and study skills. This message also encouraged students to make an appointment with their academic advisor to discuss their progress in math.

Students who did not meet with their academic advisor within one week received a follow up phone calls from both the retention and student success coordinator and their academic advisor to discuss their progress. These meetings and phone calls occurred throughout the semester, primarily focused on the middle of the 16-week semester. Calls and email reminders continued until the student met with an advisor, or the conclusion of the semester.

Table 1. Fall 2021 pre-EAIS student data

Campus	Total Students	Students with failing CRA grade	Students with failing CRA grades D F, or withdrawal	Students with Failing CRA grade Average Course Grade	Students with failing CRA grade persisted in COE major in fall 2022
Lincoln	335	69	69.57%	1.130	24.64%
Omaha	110	9	77.78%	.916	44.44%

In Spring 2022, 19 students failed the CRA on both campuses. Of those students, 13 met with an academic advisor to discuss their progress and success, and six students could not be contacted. The average grade in Calculus I of these six students was 0.333 on a four-point scale and five students received a non-passing grade of D, F or withdrew from the course. Only 33.33% of students who could not be contacted are planning to return to a COE major in the Fall 2022 semester.

The average grade in Calculus I for the 13 students who met with an academic advisor was 1.243 on a four-point scale and eight students received a non-passing D, F, or W grade. The biggest impact for this group was on retention to the engineering program, 61.54% of these students reenrolled in the fall semester as an engineering major in fall 2022.

### Conclusion and Future Work

Contacts from the retention and student success coordinator did seem to have an effect on student persistence in the engineering program even if only modest gains in course achievement were achieved. Although results for spring 2022 EAIS process are promising, additional studies are needed to determine if interventions in the fall are more impactful. Also, studies are needed to determine if having an earlier in the semester intervention would have a greater impact on course grades.

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