Prematriculation Interventions using ALEKS: Common Lessons-learned in two Programs

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Keywords: Math Intervention, Precalculus through Calc II (P2C2), Student Success.

Students who enter university level calculus without a strong mathematical foundation in algebra and functions often struggle to succeed: repeating courses, leaving STEM, or dropping out entirely (Chen, 2013). Students from traditionally underrepresented groups are at particularly high risk of STEM attrition (Alexander et al., 2009). Here we describe student behavior in two interventions designed to provide a prematriculation experience for first-year university students. Each summer intervention paired content preparation with evidence-based learning strategies in an effort to reduce STEM attrition and increase success in gateway mathematics courses.

In Canada and the United States, the COVID-19 pandemic has had a large impact on K-12 students, with a major concern being mathematical preparation. Evidence indicates that current and future incoming university students are less prepared than their pre-pandemic counterparts (NEAP, 2022; EQAO, 2022). We know that high school teachers were forced to make curricular decisions that did not have in mind calculus preparation; for example, omitting logarithmic functions from the curriculum (Sacka, 2021). To shore up the mathematical skills of incoming students in an efficient way, the programs described here make use of a popular online intelligent tutoring system called Assessment and Learning in Knowledge Spaces (ALEKS). Within ALEKS, the curriculum for each program was shaped to be closely aligned with the local context and curricula, ensuring that student engagement with the material will be served in their upcoming courses. This alignment was directly communicated to students, instructors, advisors and administrators in each program.

Despite differences in local context and format of the "non-mathematical" components of each program, we found common experiences with respect to student engagement with ALEKS:

1. ALEKS can be offered as a stand-alone product, but ALEKS alone was not sufficient to motivate student engagement or open lines of communication with faculty or peers.
2. Synchronous support for ALEKS (e.g. office hours) were underutilized, with the majority of participants in one program reporting that they were able to find answers to their questions within ALEKS. Students in both programs instead used office hours to ask questions related to placement and course selection.
3. While students in both programs retained access to ALEKS into the start of the Fall semester, very few students remained active in the platform once classes started. This result could be attributed to lack of time during this busy transitional period, and/or decrease in motivation as seen in previous applications of ALEKS (Fang et al., 2019)

In addition to these shared insights, we will also report on differences between ALEKS use across the two programs, including learning gains, time spent on ALEKS and the distribution of topics mastered. Through this poster presentation, we aim to:

- learn more about experiences with ALEKS at other institutions,
- hone in on strategies for better student engagement with the tool, and
- gauge community interest for support in analyzing the local data needed to establish and evaluate similar interventions.

References

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Why provide early support for STEM students?

Students are much more likely to succeed in university-level calculus when equipped with a strong foundation in algebra and pre-calculus. Success in Calculus is crucial for students who intend to pursue a degree in STEM. Literature suggests that without early success in college STEM courses, students may struggle to succeed: repeating courses, leaving STEM, or dropping out entirely (Chen, 2013). Students from traditionally underrepresented groups are at particularly high risk of STEM attrition (Alexander et al., 2009).

Here we describe student behavior in two summer interventions designed to provide a prematriculation experience for first-year university students.

Each summer intervention paired mathematical content with evidence-based learning strategies in an effort increase success in calculus.

Has the pandemic affected STEM-preparedness?

In Canada and the United States, attempts to measure impact of the COVID-19 pandemic indicate that current and future incoming university students may be less prepared than their pre-pandemic counterparts, with a major concern being mathematical preparation. (NEAP, 2022; EQAO, 2022).

Not all students were able to interact with the full high school curriculum; for example, some classes omitted exponential and/or logarithmic functions from the pre-calculus curriculum (Sacka, 2021).

As a result, we may see a higher degree of heterogeneity in terms of preparedness of incoming students.

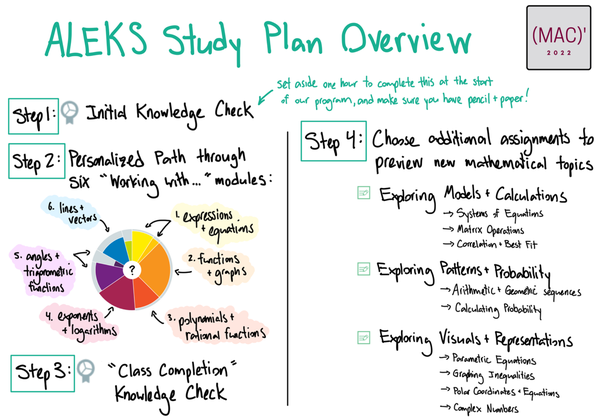
How can the intervention be customized?

To target relevant mathematical skills in an efficient way, the programs described here make use of an online intelligent tutoring system called Assessment and Learning in Knowledge Spaces (ALEKS).

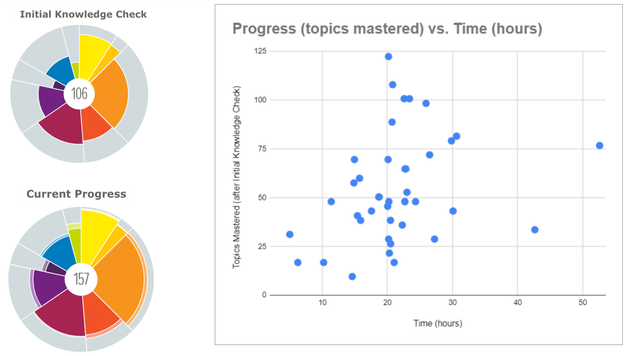
Within ALEKS, the curriculum for each program was shaped to be closely aligned with the local context and curricula, ensuring that student engagement with the material will be served in their upcoming courses.

This alignment was directly communicated to students, instructors, advisors and administrators in each program.

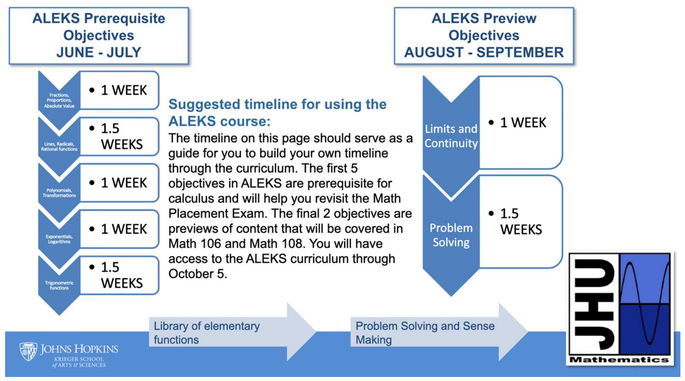
McMaster's Peer-Run Inclusive Math Experience (MacPrime)



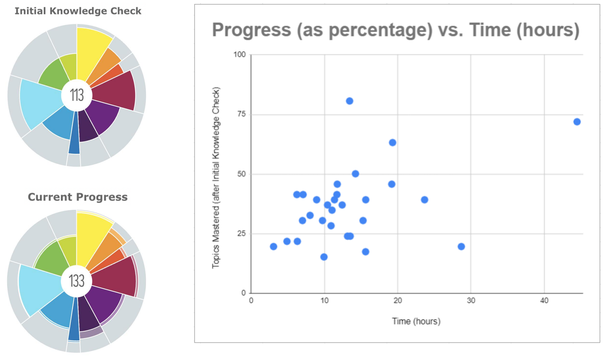
Summer 2022 - ALEKS Pie

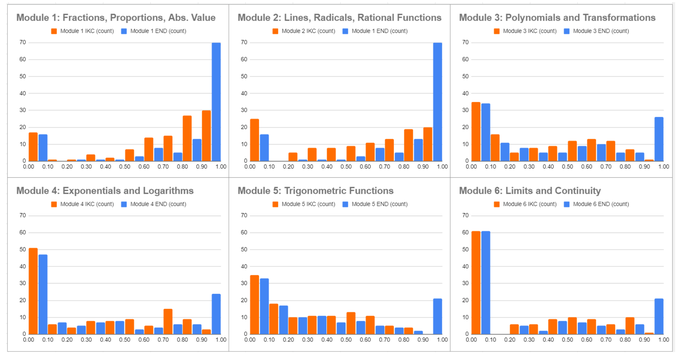


Johns Hopkins' Student Success Programs



Summer 2022 - ALEKS Pie





Student Engagement with ALEKS

- ALEKS alone was not sufficient to motivate student engagement or open lines of communication with faculty or peers.
- Synchronous support for ALEKS (e.g., office hours) were underutilized, participants at McMaster reporting that they were able to find answers to their questions within ALEKS. Students in both programs instead used office hours to ask questions related to placement and course selection.
- Time spent in ALEKS (time active in the system) was weakly to moderately correlated with progress through either program's curriculum (number of topics mastered after Initial Knowledge Check): Pearson $r = 0.30$ (McMaster) and $r = 0.43$ (Johns Hopkins),
- Very few students remained active in the platform once classes started. This result could be attributed to lack of time during this busy transitional period, and/or decrease in motivation as seen in previous applications of ALEKS (Fang et al., 2019)

Can we use program data to better "Mind the Gaps"?

Kornelson, Moore-Russo and Reeder (2020) identified six categories of algebraic errors commonly exhibited by calculus students, found in Modules 1-3 of each program:

- Simplifying
- Distributive property
- Variable isolation
- Operations with rational expressions
- Operations with radicals
- Composition of functions

The authors suggest that even when mastery of these skills is demonstrated in ALEKS, instructors should consider a just-in-time approach, as well as mitigating factors that could be causing mistakes. Data collected from these programs could provide guidance for aligning additional interventions for a given cohort of students.

We hope to learn more about:

- **Experiences with ALEKS products at other institutions (courses/programs, placement, etc.)**
- **Strategies for better student engagement with ALEKS**
- **Community interest for support in analyzing data needed to evaluate programs using ALEKS**

Take our survey:

bit.ly/3ujlyMQ

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