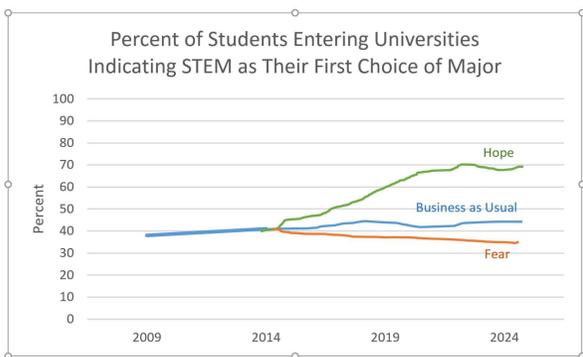


The Motivation/Purpose:

- To address the shortage of a highly skilled STEM workforce, particularly in the areas of computer science and engineering
- To address the issue of implementing new STEM initiatives in a pK-12 school district
- To address shortage of high school graduates entering post-secondary STEM programs
- The need:** Effective implementation of STEM initiatives in order to attract and prepare students to enter college STEM programs and, ultimately, the STEM workforce

Background

- In Massachusetts, the demand for new STEM employees reached over 277,000 in 2018.¹ However, of the 69,978 high school graduates, only 41% of graduates entering post-secondary institutions will enroll in a post-secondary STEM program.² Even accounting for recruits from other states and countries, there is still a significant STEM workforce shortage.
- A Strategic STEM Integration program for education leaders was developed to help high schools implement effective STEM integration initiatives.



STEM Readiness

- Operationalized for this study as students achieving proficient or advance on the Massachusetts State exam in Science, Technology, and Engineering
- 39% of students enter high school STEM ready³
- In high school, the number of new students that become STEM ready is affected by exposure to STEM content through courses
- Student conversion is also impacted by teacher effectiveness, modeled as experience gained through number of years teaching and efficacy gained through professional development

Methodology

- Using System Dynamics modeling techniques will help education leaders understand their system in order to make better policy implementation decisions.
- A System Dynamics model was developed using average state data to generalize district system components that impact the effectiveness of STEM integration
- The primary goal is to increase the number of high school students who pursue STEM education in a higher education institution. Supporting objectives include increasing teacher efficacy in teaching STEM and student efficacy in learning STEM.

Research Questions

- Question 1:** What are the variables that determine the impact of teacher and district STEM capacity on the number of students entering college STEM programs?
- Question 2:** To what extent can system dynamics models of STEM education systems be predictive of success in STEM improvement efforts?

Administrative Level Decisions

Three decision points were included in the model to represent decisions school administrators can make to leverage change when implementing district policy decisions. These are indicated in the model in purple boxes and include the following:

Number of STEM Teachers

- Number of teachers and support staff hired
- Modeled as average hiring rate

STEM Teacher Development

- STEM Professional Development
 - Increase in PD results in greater experience
 - Greater experience through both PD and number of years of teaching increases teacher effectiveness
 - Increased teacher effectiveness increases the conversion rate of students from non-STEM to STEM ready

MCAS Score Goal

- Drives number of STEM courses offered
- Impacts teaching load
- Unintended consequence – teachers leave the profession if work stress is too high

Implications/Future Work

- Model validation
- Integration of Service Science and System Dynamics
 - Service Science Canvas
 - Static data to inform the dynamic model
 - Apply to 4 identified schools with varying success in STEM integration
- Education Leaders Professional Development Workshops
 - Structured protocol to elicit mental models based on the service science canvas
 - Group model building with districts to reflect the dynamic nature of their school system
 - Guided strategic decision making to improve STEM integration implementation

References

- Department of Elementary and Secondary Education. (2018, September 27). MCAS Achievement Results. Retrieved from School and District Profiles: Statewide Reports: <http://profiles.doe.mass.edu/statereport/mcas.aspx>
- Executive Office of Labor Workforce and Development (EOLWD), E. O. (2016, September 30). Long Term STEM Occupational Projections. Retrieved from Labor Market Information: http://lmi2.detma.org/Lmi/Occupation_Projection_jobSTEM.aspx
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Model of the Massachusetts Public School System

