Knowing Your Students

The Power of Learning Analytics

Piriya Utamachant

Asian Institute of Technology (AIT)

A common goal of Teaching :

To Maximize Students' Opportunity to achieve expected Learning Outcomes.

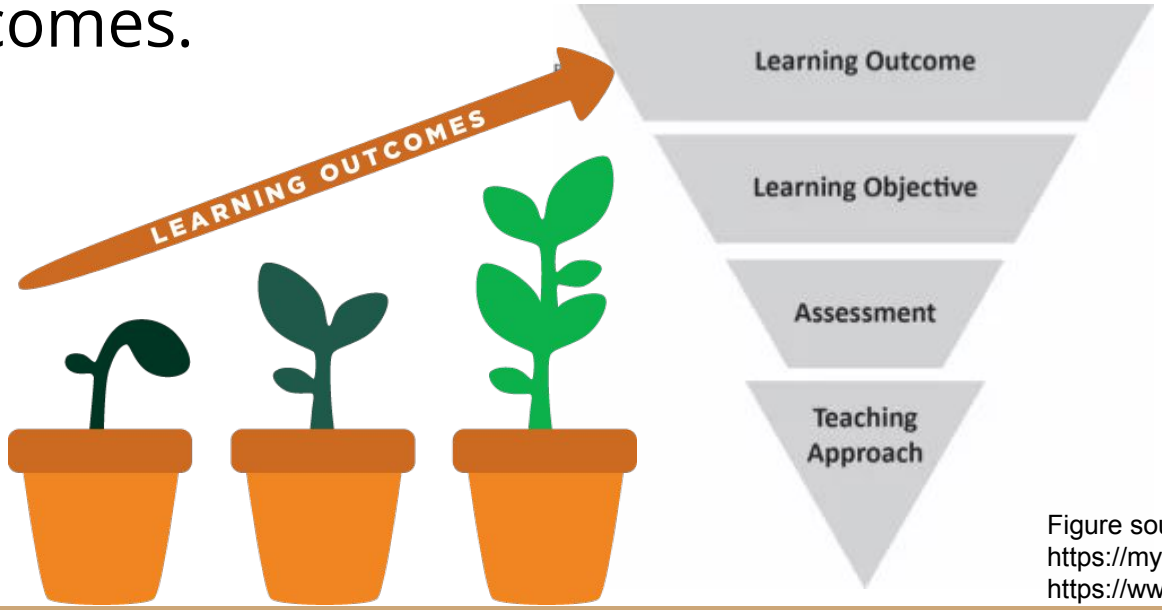


Figure source :
https://mystory.msu.edu/
https://www.celt.iastate.edu/

What is Learning Analytics?

“An application of Data science on Education Domain”

Measurement, Collection, Analysis and Reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.

Figure Sources
https://www.govtech.com/education/note-taking-in-lectures-laptops-or-longhand.html
https://www.huffpost.com/entry/4-ways-your-college-class_b_3658223

Instructor-Led courses

Student-Centered Education

Timeframe	Student-centered	Instructor Activity
Before course start	Who students are?	• Set Learning Outcomes/Objectives • Review Student Background • Design Course Materials • Plan for Instructional Delivery
During course instruction	How students learned?	• Monitor Learning Activities • Monitor Students' Understanding • Apply Learning Interventions (e.g.Adjusting Delivery / Material)
After course finish	How to improve student's learning outcomes	Review and optimize course for the next run

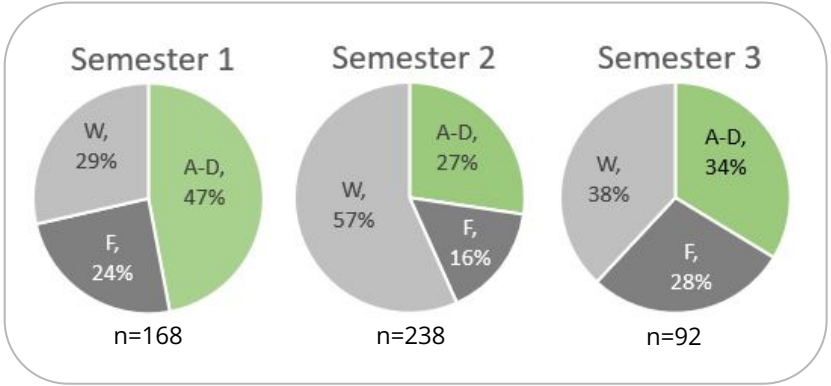
A Demonstration of Learning Analytic

Java Programing Course

A required course in Undergrad Computer Science Curriculum in a Thailand University

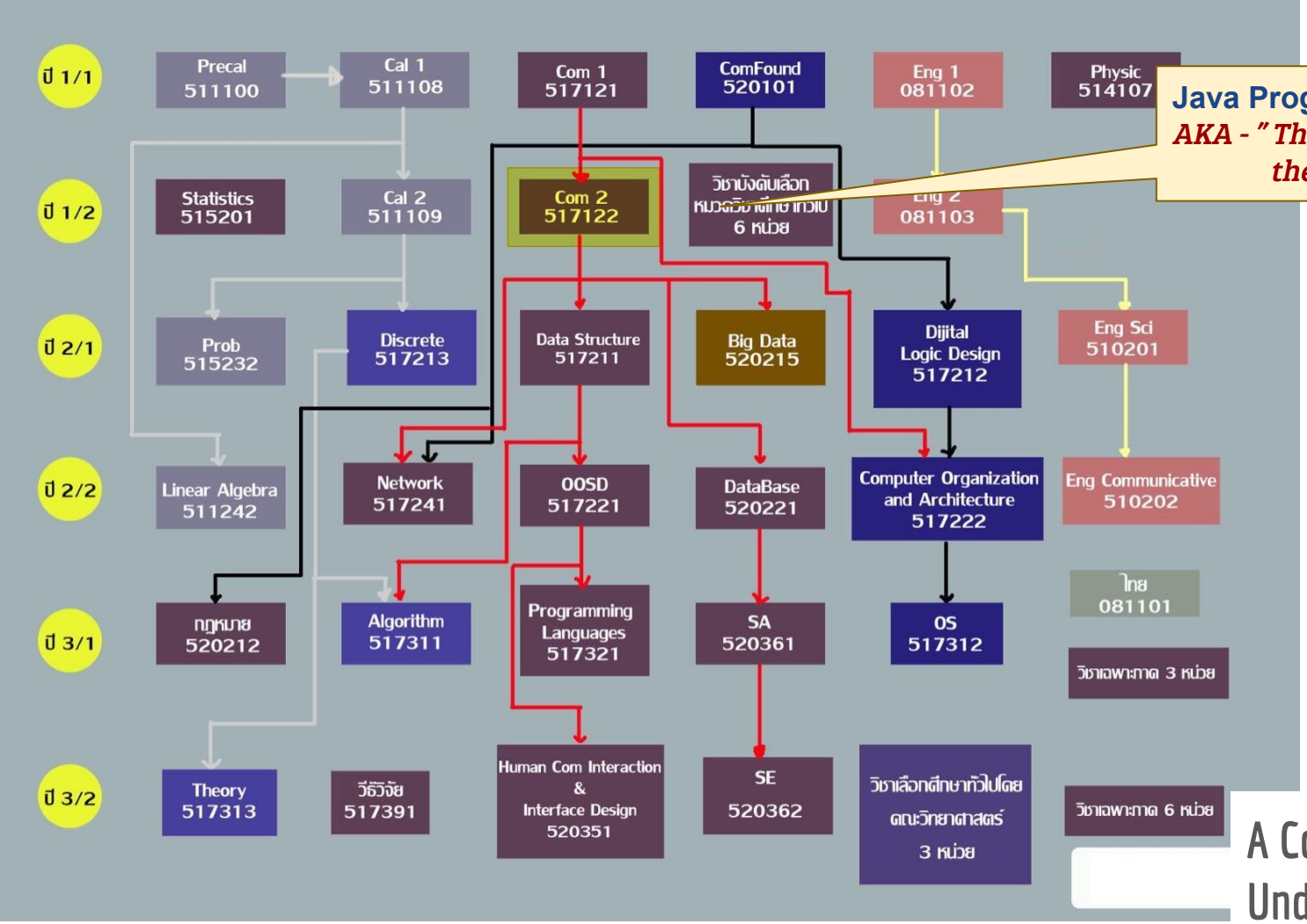
Challenges

- Recent 5 years, Student Pass Rate < 50%
- Average class size 100-250 students.
  Only 2 instructors
- Study from Home - Covid19



Goal : To Increase Student Pass Rate

- What are the different factors between Pass and Fail students ?
- Can we use the factors to identify At-risk students for preventive intervention ?

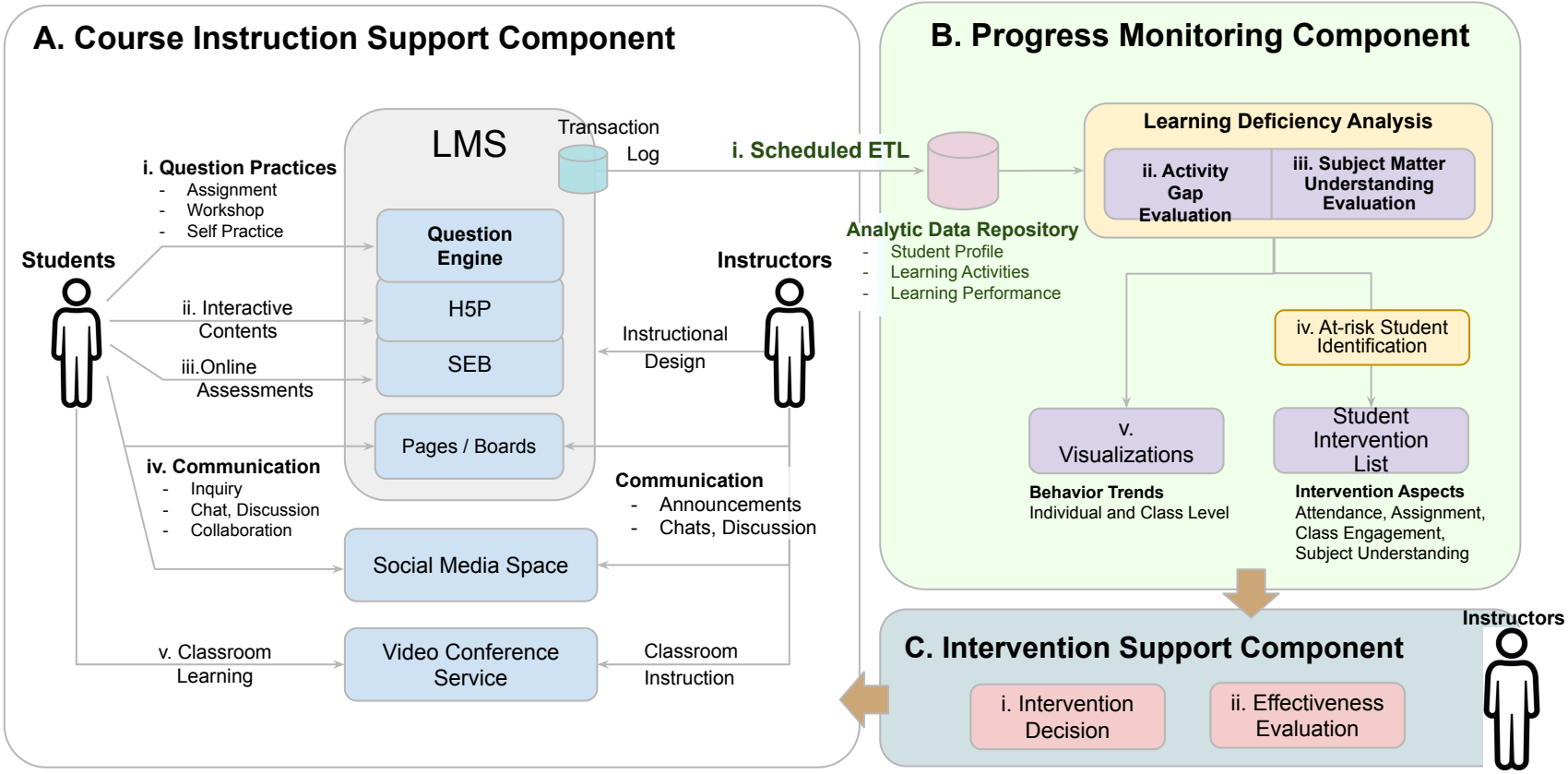


Java Programing Course

AKA - "The bottleneck of the curriculum"

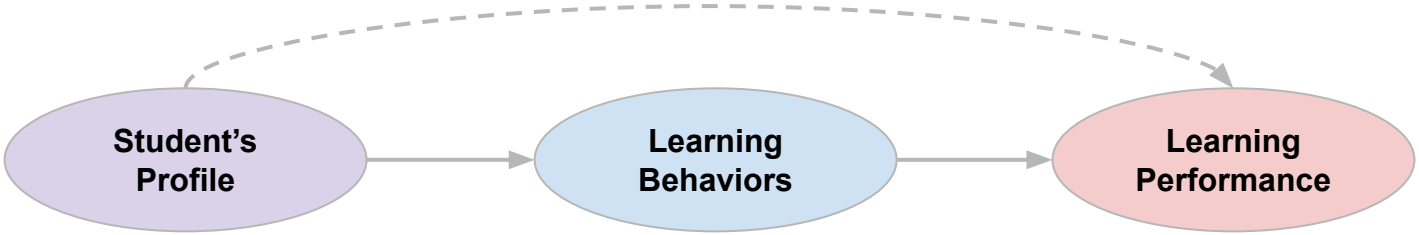
A Computer Science UnderGrad Curriculum

Instructional Platform and Data Management



Data Elements of Student Learning

Exclude Instructional Material, Design and Delivery



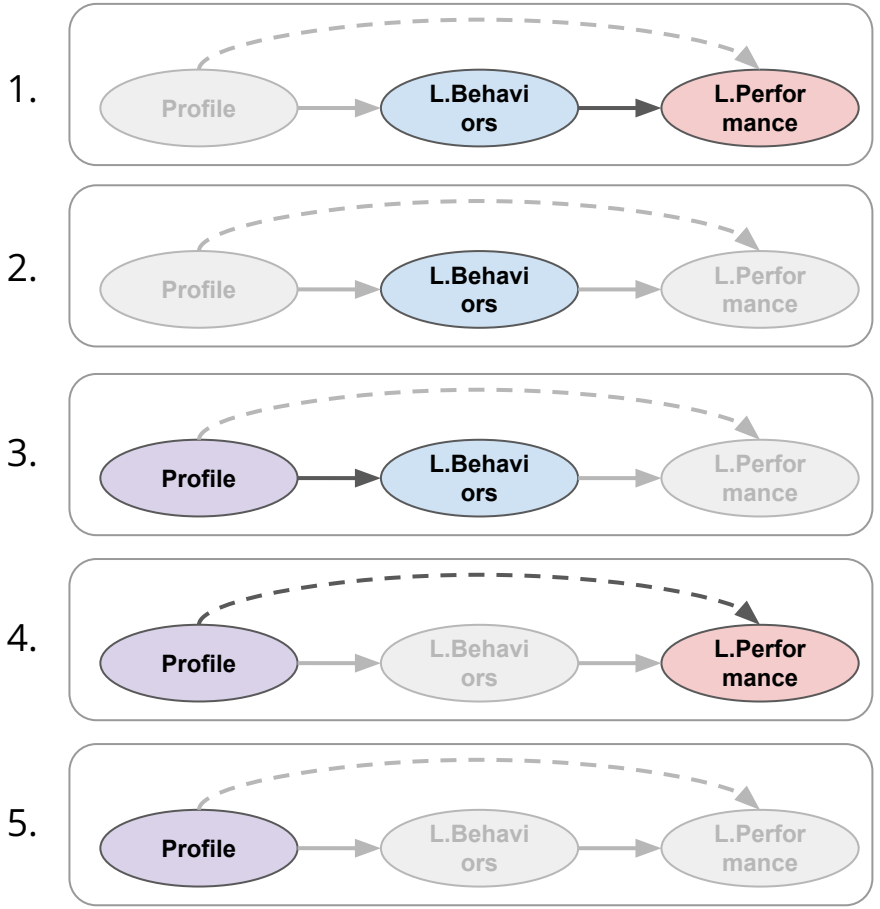
Data Collected
- Demographic
- Background Knowledge
- Learning Motivation (MSLQ)
- Learning Styles (ILS)

Data Collected
- Attendance Rate
- Class Engagement Rate
- Assignment Rate
- VDO watching Rate
- Question Practice Rate

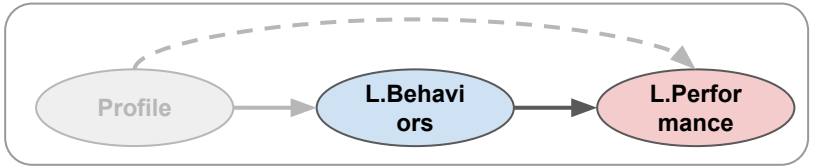
Data Collected
- Exam Score
- Assignment Score

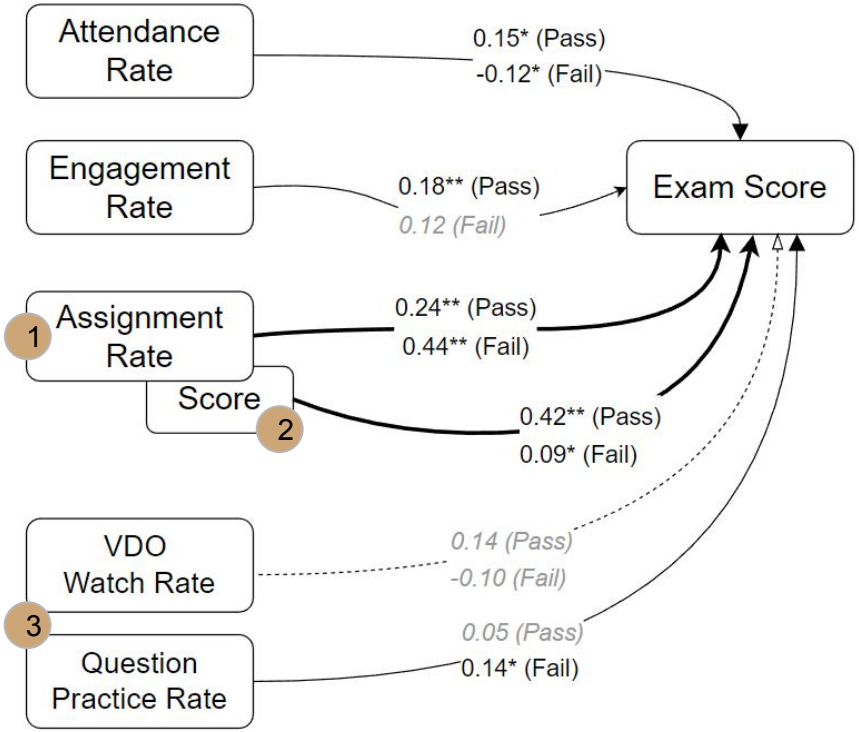
Research methodology

Analyse Relationship Level between elements



1. Learning Behavior -› Learning Performance



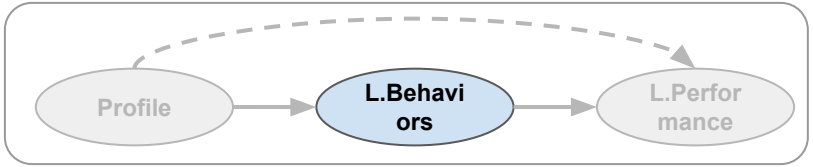


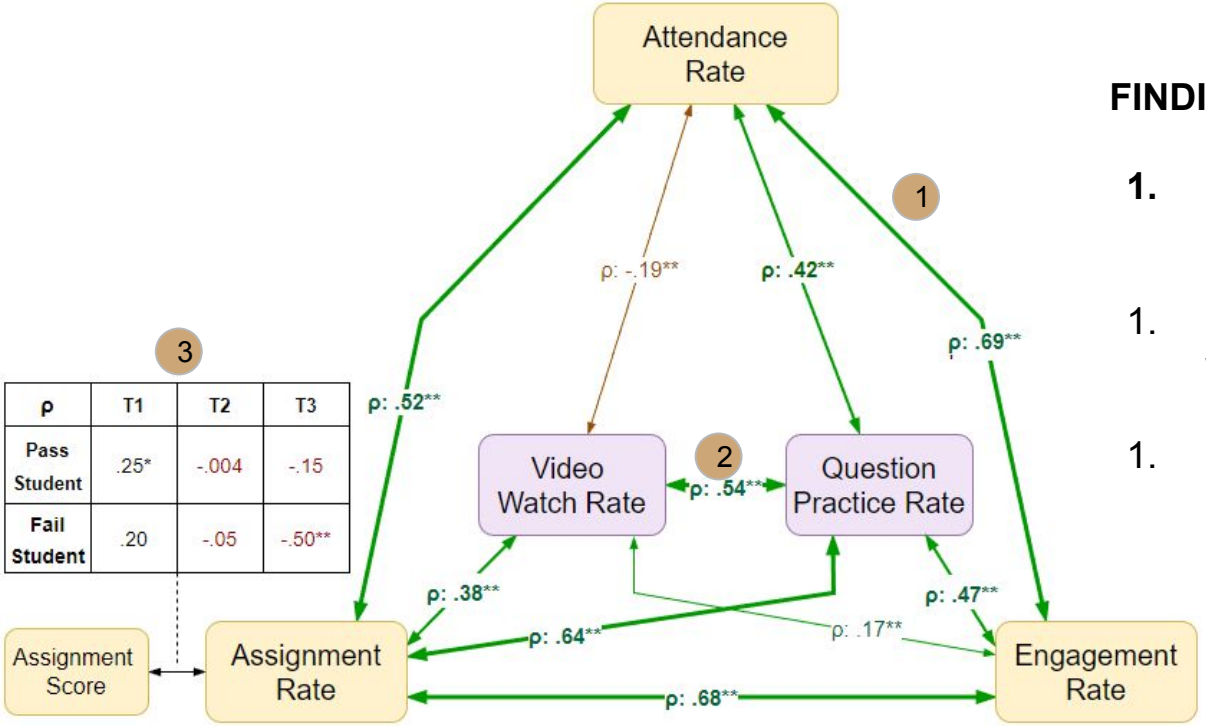
Standardized Coefficients (Beta) Multiple Regression
**p <0.05 , *p <0.10

FINDINGS

1. **Assignment rate** has the most affect
1. **Pass student** gained more **Assignment Score**
1. **Self-Study** (VDO,Question) not affect

2. Learning Behavior Network





Spearman Correlation Coefficient (ρ)
**p <0.05 , *p <0.10

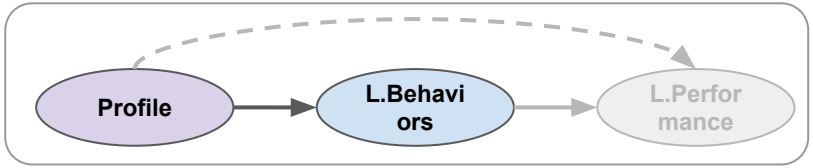
FINDINGS

1. **Key Activities** are highly **correlate** (Attendance,Assignment,Engagement)

1. Students practiced **Question** along with watching **VDO** of Class recording.

1. Put new questions as assignments in T2 and T3 result in **negative** assignment **score**

3. Student Background -› Learning Behaviors



3

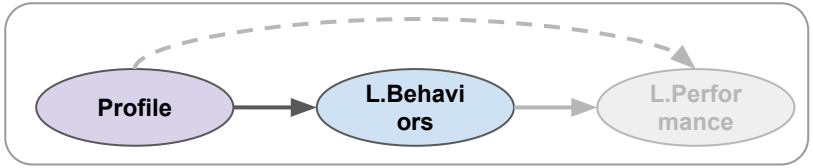
	Student's Background	Attendance Rate	Engagement Rate	Assignment Rate	Assignment Score	VDO Watch Rate	Question Practice Rate
1	Year of Study	-.237**	-.137*	.148**	.183**	.098*	-
	#Enrollment	-.092*	-	.195**	.114*	-	-
2	C Programming Grade	.088*	.122**	.174* : Pass -.122* : Fail	-	-	.156**
	Programming BG	-	-	-	-	-	-
	Pre College - STEM	-	-	-	-	-	-
	Tutor Style Pref	-	-	-	-	-	-

FINDINGS

1. **Re-attempt** students showed inferior **Learning Behaviors**
2. Students with **Good Grade** from **pre-requisite** course had better **Learning Behaviors**
3. **Re-attempt** students try to **gain points** from **assignments**

Spearman Correlation Coefficient (ρ)
**p <0.05 , *p <0.10

3. Student's L.Motivation - Learning Behaviors



Learning Motivation	Attendance Rate	Engagement Rate	Assignment Rate	Assignment Score	VDO Watch Rate	Question Practice Rate	
Intrinsic Goal	.165**	.198**				.142*	
Extrinsic Goal	.139**						
Perceive Importance/ Usefulness	.153**		.220**			.135*	
Plan-Monitor-Regulate Congnitive	.219**	.235**	.272**			.131*	1
Time/Environment Management	.352**	.445**	.405**			.255**	
Effort Regulation	.259**	.338**	.303**	.216** : Pass		.242**	
Committed Week Effort	.107*		.169**		.140**	.199**	
Peer Learning		-.163* : Pass .159* : Fail	-.031 : Pass .223** : Fail	0.025 : Pass .137* : Fail	-.204* : Pass .057 : Fail		2
Help Seeking		-.090* : Pass .186** : Fail	-.103 : Pass .188** : Fail	-.062 : Pass .204** : Fail	-.251** : Pass .003 : Fail		

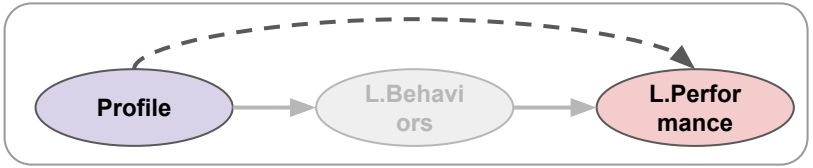
Spearman Correlation Coefficient (ρ)
**p <0.05 , *p <0.10

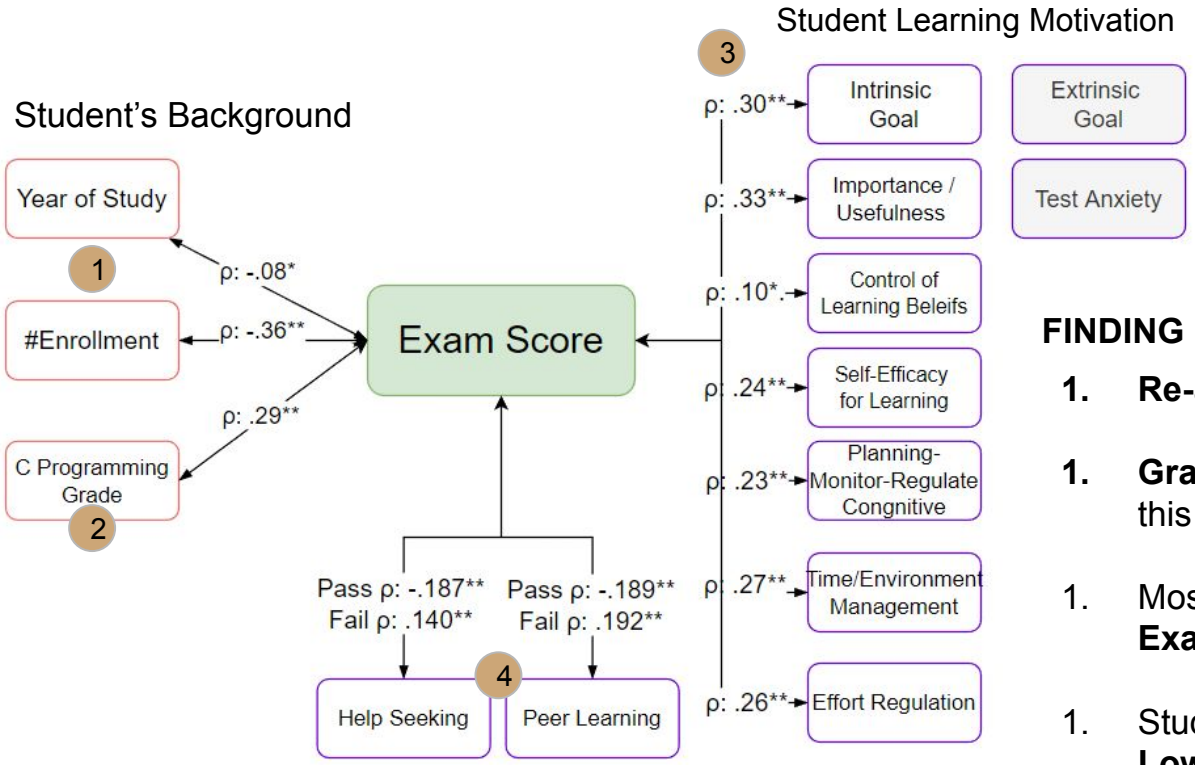
FINDINGS

1. Most Learning **Motivations** correlated with **Learning Behavior** There are 3 categories standing out.

1. **Pass Students** are more **independent on learning** while Fail students tends to rely on other.

4. Student Profile -› Learning Performance





Spearman Correlation Coefficient (ρ)
**p <0.05 , *p <0.10

FINDING

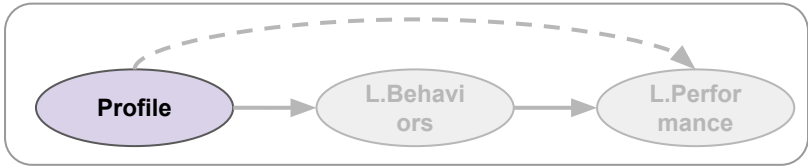
1. **Re-attempt** students gained **Lower Score**

1. **Grade of pre-requisite** course correlate with this **Exam Score** of this course

1. Most Learning **Motivations** correlate with **Exam Score**

1. Students who **depending on others** gain **Lower Exam** Score

5. Student Background -› Learning Motivation



Learning Motivation	Year of Study	#Enrollment	C Programming Grade	Programming Course BG
Intrinsic Goal	-.213**	-.153**	.243**	.100*
Extrinsic Goal (1)				(2)
Importance/Usefulness	-.222**	-.129*	.214**	
Self Efficacy	-.204**	-.275**	.287**	.175**
Plan-Monitor-Regulate Congnitive	-.173**			
Time/Environment Management				
Effort Regulation	-.155**			
Committed Week Effort				
Peer Learning (3)	.247* : Pass -.056 : Fail	.271** : Pass .094 : Fail	.115*	.100*
Help Seeking (3)	.168* : Pass -.028 : Fail	.210* : Pass .040 : Fail		
Test Anxiety	.145**		-.126*	

Spearman Correlation Coefficient (ρ)
**p <0.05 , *p <0.10

FINDINGS

1. **Re-attempt** students showed **Lower Motivations**.

1. Students with **good grade** from **pre-requisite** course had better **Motivation**

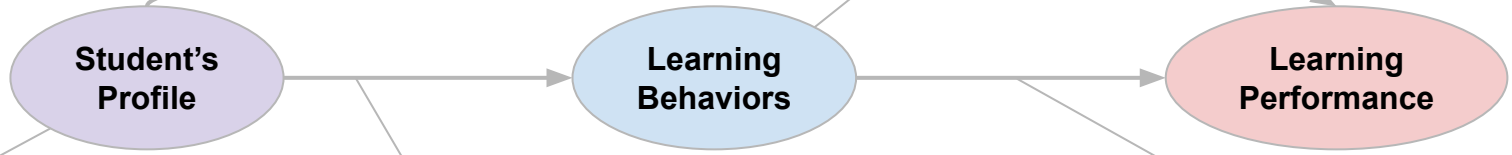
1. **Re-attempt Students** who **Pass** are more **independent** on learning while Fail students tends to rely on other.

Significant Relationships

Attendance Rate	Atcn%
Engagement Rate	Engm%
Assignment Rate	Asmn%
Assignment Score	Asmn. Scr
VDO Watch Rate	VDO%
Question Practice Rate	Qn%

- **ReAtmp x Exam Score**
  The more students reattempt the worse performance
- **PreReq.Grd ↔ Exam Score**
  Grade from pre-requisite course prove solid programming skill
- **L.Motiv ↔ Exam Score**
  Good Learning Motivations go with Exam Score
- **L.Motiv x Exam Score**
  Pass student learn independently, vice versa (Less HlpSeek,PeerLearn)

- **Atdn% ↔ Engm% ↔ Asnm%**
  Key activities highly correlate. Focus on **Atdn%** should be most effective
- **Qn% ↔ VDO%**
  VDO recording is important for Self Question practice



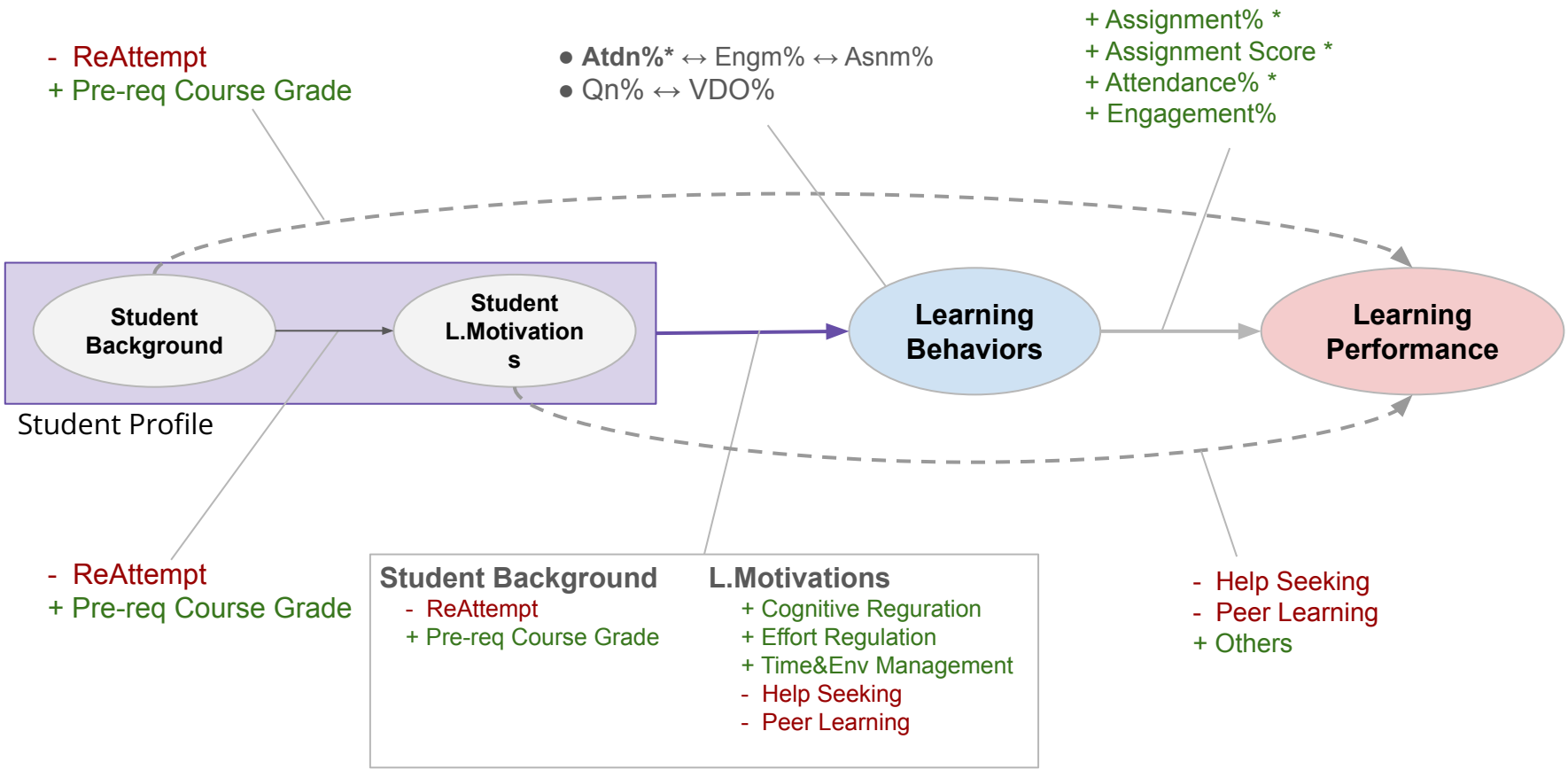
- **ReAtmp x L.Motiv**
  - The more student reattempt the worse overall learning motivations.
  - Reattmpt students relied on others (More HlpSeek,PeerLearn)
- **PreReq.Grd ↔ L.Motiv**
  Students with good previous course Grade had good Learning Motivation

- **ReAtmp x L.Behavior**
  Reattempt students inferior learning behaviors (Atdn%,Engm%)
- **PreReq.Grd ↔ L.Behavior**
  Students with good previous course Grade show good L.Behavior
- **L.Motiv ↔ L.Behavior**
  Cognitive Regulation, Effort Regulation ,Time&Env Management
- **L.Motiv x L.Behavior**
  Pass student learn independently, vice versa (Less HlpSeek,PeerLearn)

- **Asnm% ↦ Exam Score**
- **Asnm.Scr ↦ Exam Score**

Asgm.Scr is a strong predictor for Final Score. (Avoid repeated questions)

Significant Relationships



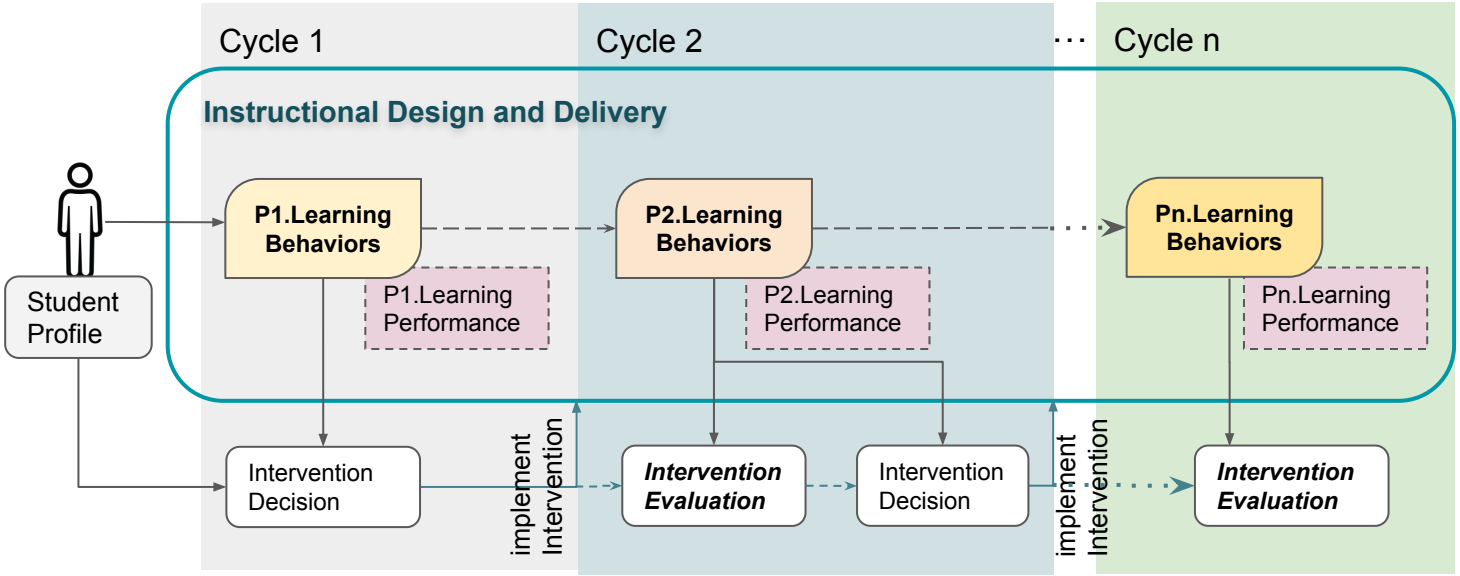
How to increase Student Pass Rate ?

A. Implement Interventions to improve student's learning

1. Monitoring Significant Learning Behaviors
2. Identify At-risk Student and apply proper Intervention
3. Evaluate the intervention results

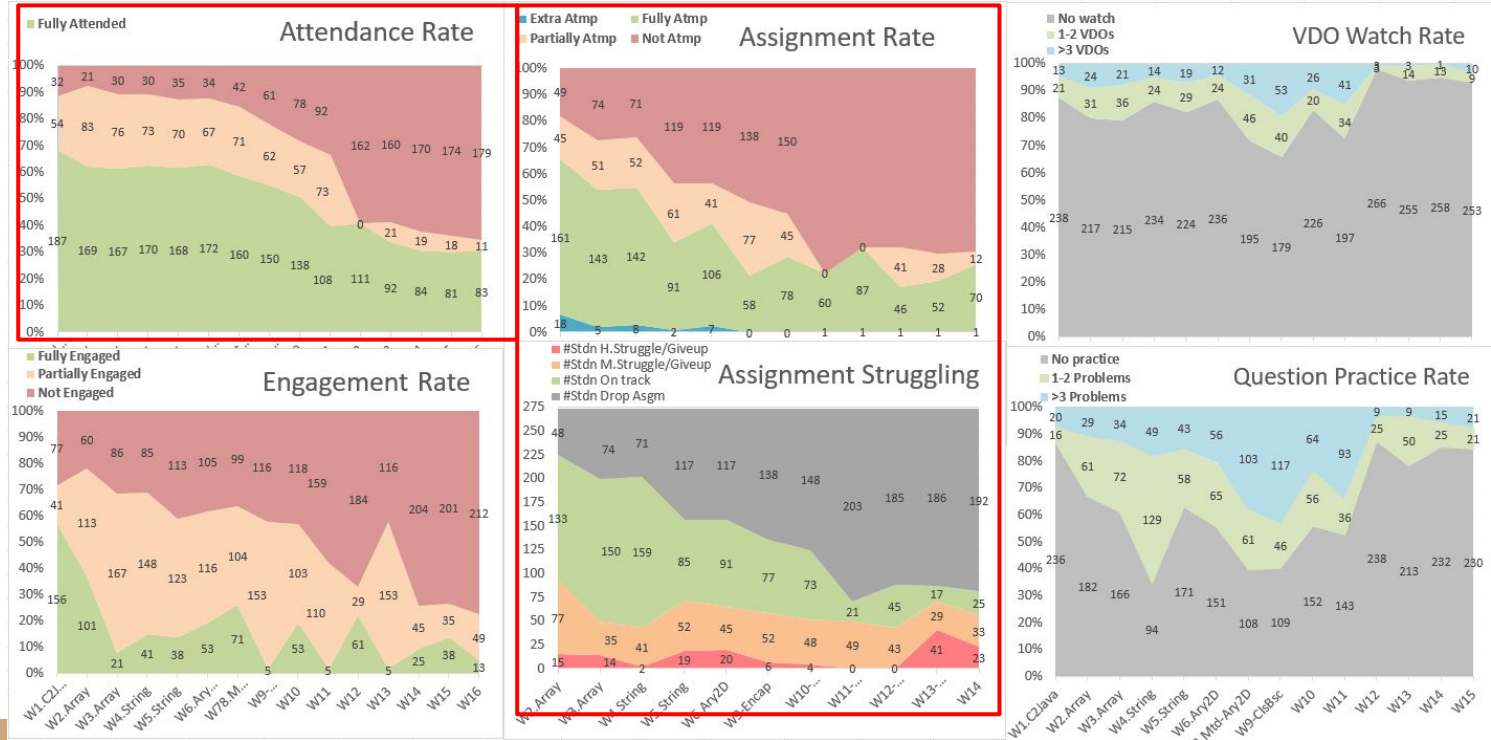
B. Course Design and Delivery Improvement

Intervention Cycle to Improve Student's Learning



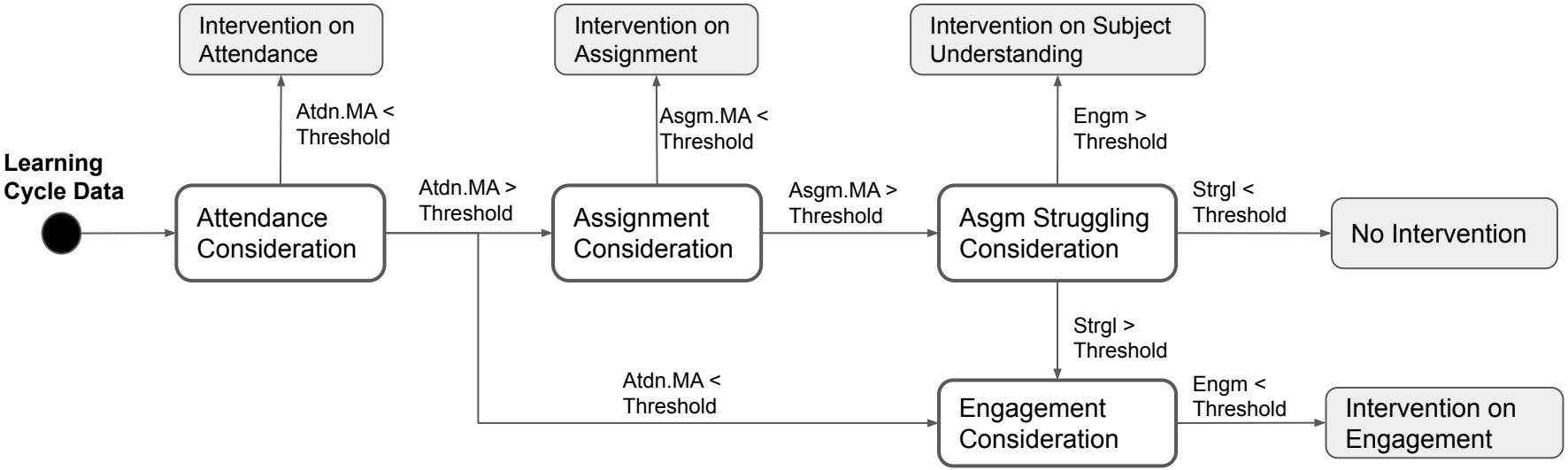
1. Monitoring Significant Learning Behaviors

#1 : Look out for **Attendance Rate** Drop
#2 : Look out for **Assignment Rate** Drop
#3 : Take care of Struggling Students (**Assignment Score**)



2. At-Risk Student Identification

Measure from Learning Behavior



3. Intervention Experiment and Evaluate (Semester2)

Intervention on Attendance	**% Effectiveness** (Improved:Unimproved)
Week5 : Sending email to encourage	45% (19:23)
Week7 : Sending email to emphasis the importance of Atdn	71% (20:8)
Week11 : Reminding minimum attendance rate to pass	83% (15:3)

Intervention on Assignment	**% Effectiveness** (Improved:Unimproved)
Week6 : Sending email to encourage	23% (14:48)
Week10 : Sending customized message email acc to their assignment work pattern	46% (13:15)
Week12 : Reminding extra score from Assignment rate	55% (36:29)

Intervention on Subject Understanding Small Group Sessions	**Attended : Unattended**	
Array1D	Students = 14 : 106	Average Scores = 2.93 : 2.80
Array2D	Students = 37 : 28	Average Scores = 1.51 : 1.43
String	Students = 14 : 74	Average Scores = 7.86 : 6.18
Class Basic	Students = 22 : 37	Average Scores = 8.24 : 3.81**
Array of Objects	Students = 9 : 62	Average Scores = 6.66 : 2.74**

Mann-Whitney U Test

Enhancing Intervention

Factor in Student Profiles

Student Background - L.Behavior	**Enhance Intervention Approach**
Negative ● Reattempt Students ● Low Pre-Requisite Grade Students	● Optimize At-Risk Student Identification with these features ● Apply distinctive approach to this specific group

L.Motivation - L.Behavior	**Enhance Intervention Approach**
Positive ● Intrinsic Goal, Extrinsic Goal ● Perceive Importance Usefulness ● Plan-Monitor-Regulate Cognitive ● Time/Environment Management ● Effort Reguration Negative ● Peer Learning ● Help Seeking	Increase Subject Interest ● Discuss Importance and Usefulness of skills in the course and future careers ● Create challenges in course e.g. gamification Promote Individual Problem Practice ● Setup sessions with dedicated time for “Doing by yourself” ● Provide systematic problem solution minimizing “Empty Head - Await Solution” Carrot and Stick - Use with caution!

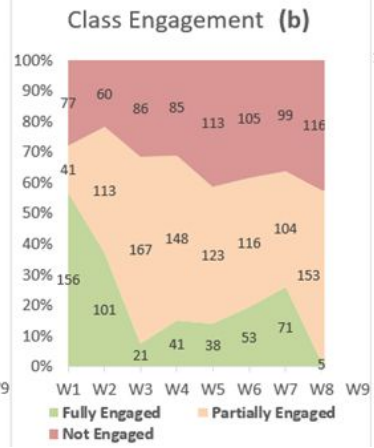
Potential Analytics (Future works)

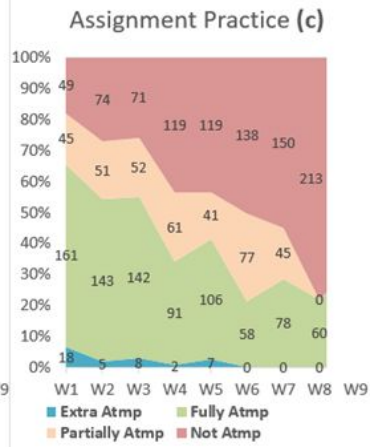
- Drop Students Analysis
- Repeated Student Analysis
- Question Practice Analysis
- Video Watching Analysis
- Code Analysis

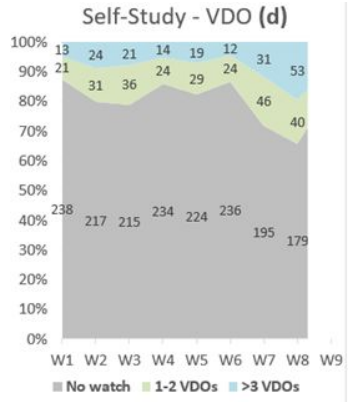
Many more...

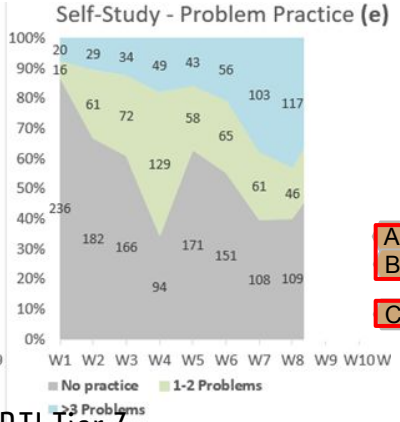
Thank you

Visualization - Learning Behaviors









	UserID	Total Class Attendace	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15
	43	61%	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
	45	54%	0.5	1.0	1.0	1.0	1.0	0.3	0.7	1.0	0.3	0.7	0.0	0.0	0.0	0.0	0.0
A	46	95%	1.0	1.0	1.0	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
B	48	83%	1.0	0.3	1.0	0.7	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	0.7	0.0
	49	0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	50	78%	1.0	0.7	0.7	1.0	0.7	1.0	0.7	0.7	0.7	0.0	1.0	1.0	1.0	1.0	1.0
	56	22%	0.0	0.3	0.7	0.7	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	UserID	Total Class Engagement	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15
	43	37%	0.7	0.8	0.5	0.9	0.5	0.4	0.3	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0
	45	21%	1.3	0.2	0.2	0.7	0.0	0.0	0.2	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0
A	46	89%	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	0.8	0.6	1.0	1.0	1.0	1.0	0.5
B	48	11%	0.7	0.8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	49	0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	50	5%	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
	56	4%	0.0	0.3	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	UserID	Total Assignment	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15
	43	28%	na	1.0	1.0	1.0	0.5	0.0	na	na	0.2	0.0	0.0	0.0	0.0	0.0	0.0
	45	19%	na	0.5	0.5	1.0	0.5	0.0	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A	46	96%	na	1.5	1.5	1.0	1.0	0.5	na	na	1.0	1.0	1.0	1.0	1.0	1.0	1.0
B	48	0%	na	0.0	0.0	0.0	0.0	0.0	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	49	0%	na	0.0	0.0	0.0	0.0	0.0	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	50	75%	na	1.0	1.0	1.0	0.5	1.0	na	na	0.2	1.0	1.0	0.0	1.0	1.0	1.0
	56	0%	na	0.0	0.0	0.0	0.0	0.0	na	na	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	UserID	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15
	43	0	0	0	0	0	0	2	0	0	0	6	0	0	0	0
	45	0	0	0	0	0	0	1	15	0	0	0	0	0	0	0
A	46	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
B	48	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0
	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	50	0	0	1	0	4	2	0	1	3	0	1	3	0	1	0
	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	UserID	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15
	43	0	2	1	2	1	0	5	7	0	0	4	0	0	2	1
	45	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
A	46	0	2	3	11	2	3	7	9	10	8	0	2	1	2	2
B	48	0	0	0	0	0	0	0	7	0	1	0	0	0	0	0
	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	50	0	0	2	0	0	3	4	3	12	7	1	1	2	1	3
	56	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Class Level - support RTI Tier 3

Individual Level - support RTI Tier 2 & 1