Modeling Learning Motivation of Students Based on Analysis of Class Evaluation Questionnaire

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Kitami Institute of Technology

Introduction

Questionnaire used in our university

20120508

北見工業大学授業アンケート

授業科目コード							系列・学科等名	
科　目　名							学　籍　番　号	
教　員　名							学　生　氏　名	

このアンケートは、当該科目の現状を把握するとともに、今後の改善に役立てることを目的として実施するものです。以下の各設問についてあなたが該当していると思う箇所の ( ) を1つ塗りつぶし、意見等がある場合は、その箇所の「自由記述欄」に記入してください。

マーク記載例
良い例: ●
悪い例: ⊘ ✓ ✓ ✓ ◎ ●

1）授業内容

質問① シラバスの内容に沿って授業が行われましたか。

(a) そのとおりに行われた
(b) 大体行われた
(c) かなり異なって行われた
(d) 全く異なって行われた
(e) よくわからない

自由記述欄

質問② 授業の分量は適切でしたか。

(a) 多すぎた
(b) 少し多かった
(c) 適切であった
(d) 少し少なかった
(e) 少なすぎた

自由記述欄

質問③ 授業の難易度は適切でしたか。

(a) 難しすぎた
(b) 少し難しかった
(c) 適切であった
(d) 少し易しかった
(e) 易しすぎた

自由記述欄

2）教材

質問④ 教科書、教材（テキスト、資料）を使用した場合、その内容は授業の理解や自主学習に役立つものでしたか。

(a) 非常に役に立った
(b) 大部分は役に立った
(c) どちらかと言えば役に立った
(d) ほとんど役に立たなかった
(e) 他の教材もしくは教材を使って欲しかった

自由記述欄

※裏面もあります。

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自由記述欄

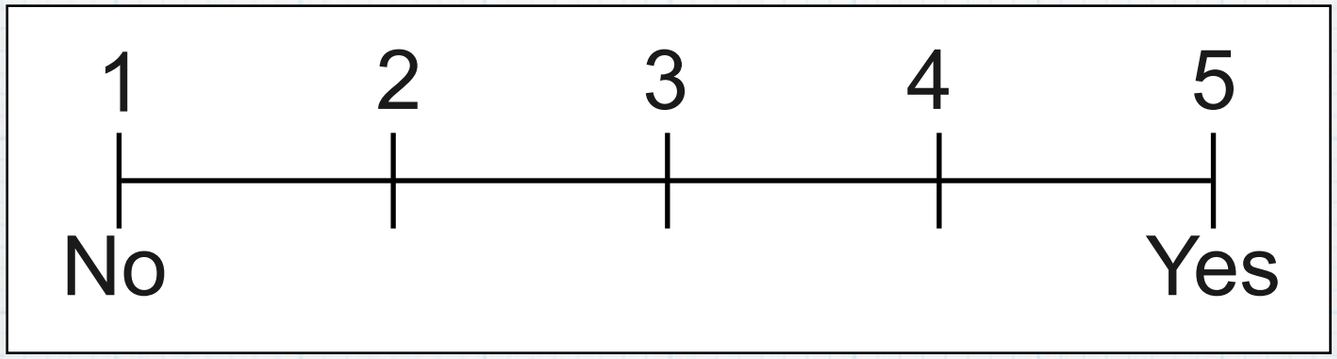
※裏面もあります。

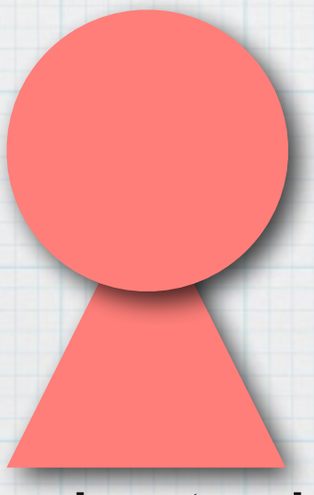
Goal of this research

Utilize results of the questionnaire
to improve the classes in the future

Introduction

Q. Were you satisfied with this course?



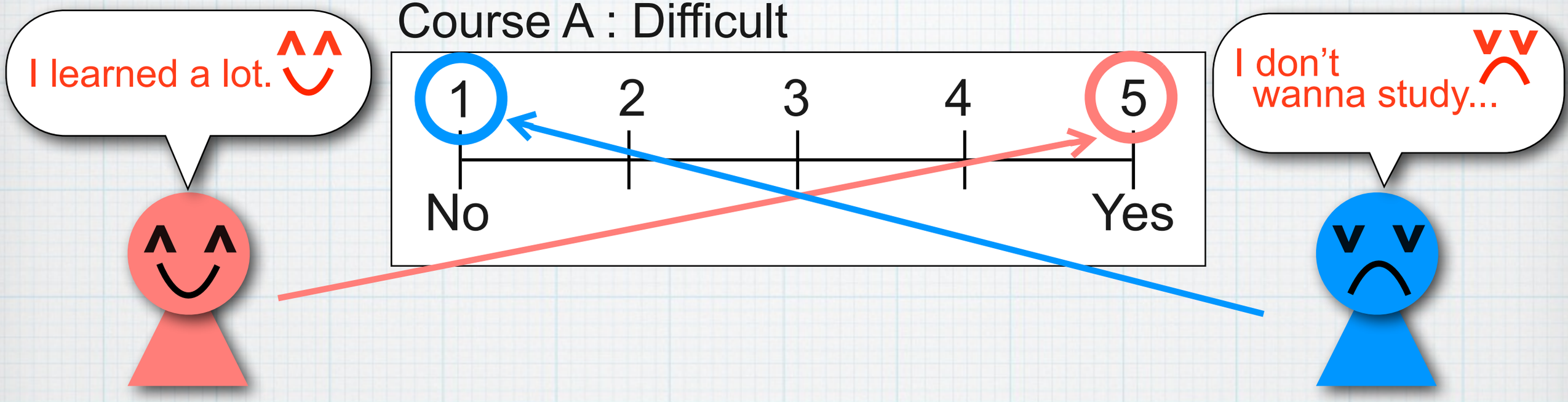


Student with
high learning motivation

Student with
low learning motivation

Introduction

Q. Were you satisfied with this course?



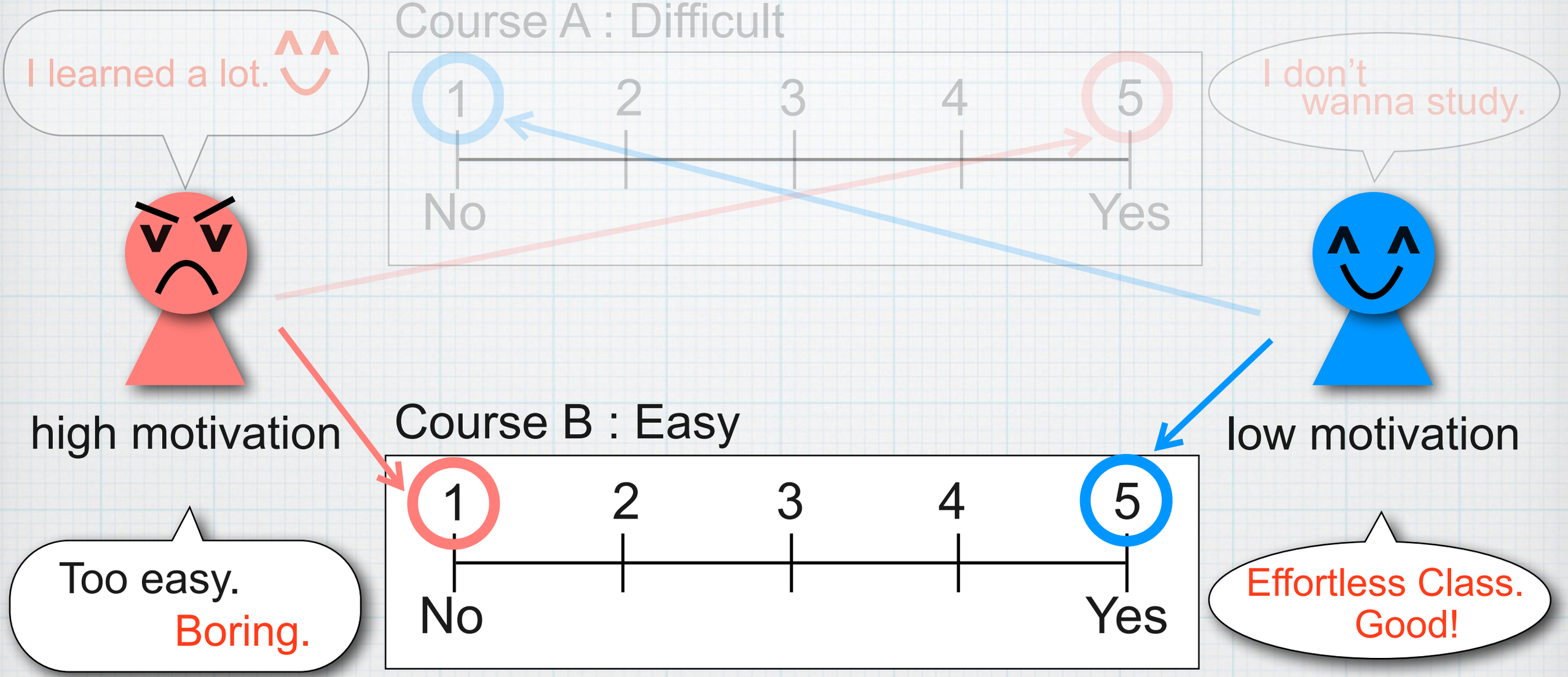
Course B : Easy

1 2 3 4 5

No Yes

Introduction

Q. Were you satisfied with this course?



Introduction

Q. Were you satisfied with this course?

Course A : Difficult

I learned a lot.

I don't wanna study.

Insufficient evaluation!

high motivation

motivation

Useless for course improvement

Too easy. Boring.

No

Yes

Effortless Class. Good!

Introduction

Solution

- Develop learner's model which

In our study

- Define learning motivation

- Represent learning motivation

Quantitative Learner's Motivation Model (QLMM)

What's QLMM?

- A model composed of basic elements
  representing attitude of students towards the attended courses

→ **Quantification of those elements**
represents the general level of learning motivation

Quantitative Learner's Motivation Model (QLMM)

Learning Motivation

- ``The will to learn the contents provided in the class''

▼

- To calculate it we consider three elements

(1)

(2)

(3)

→ Corresponds to the points of view included in the

``Application of the ARCS model of motivational design'' [Keller et al.(1987)]
``Use if the ARCS motivational model in courseware design'' [Keller et al.(1988)]

Quantitative Learner's Motivation Model (QLMM)

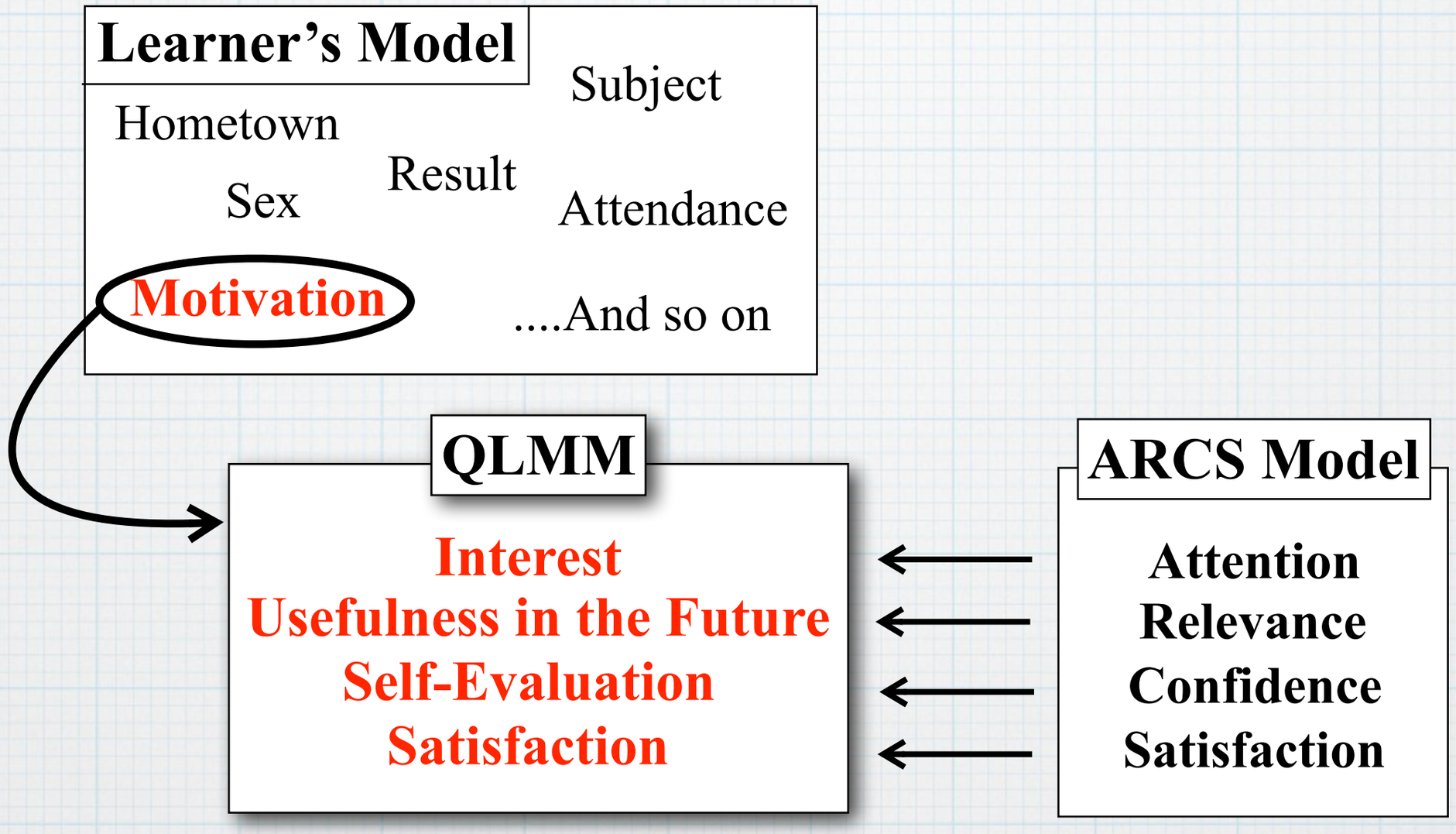
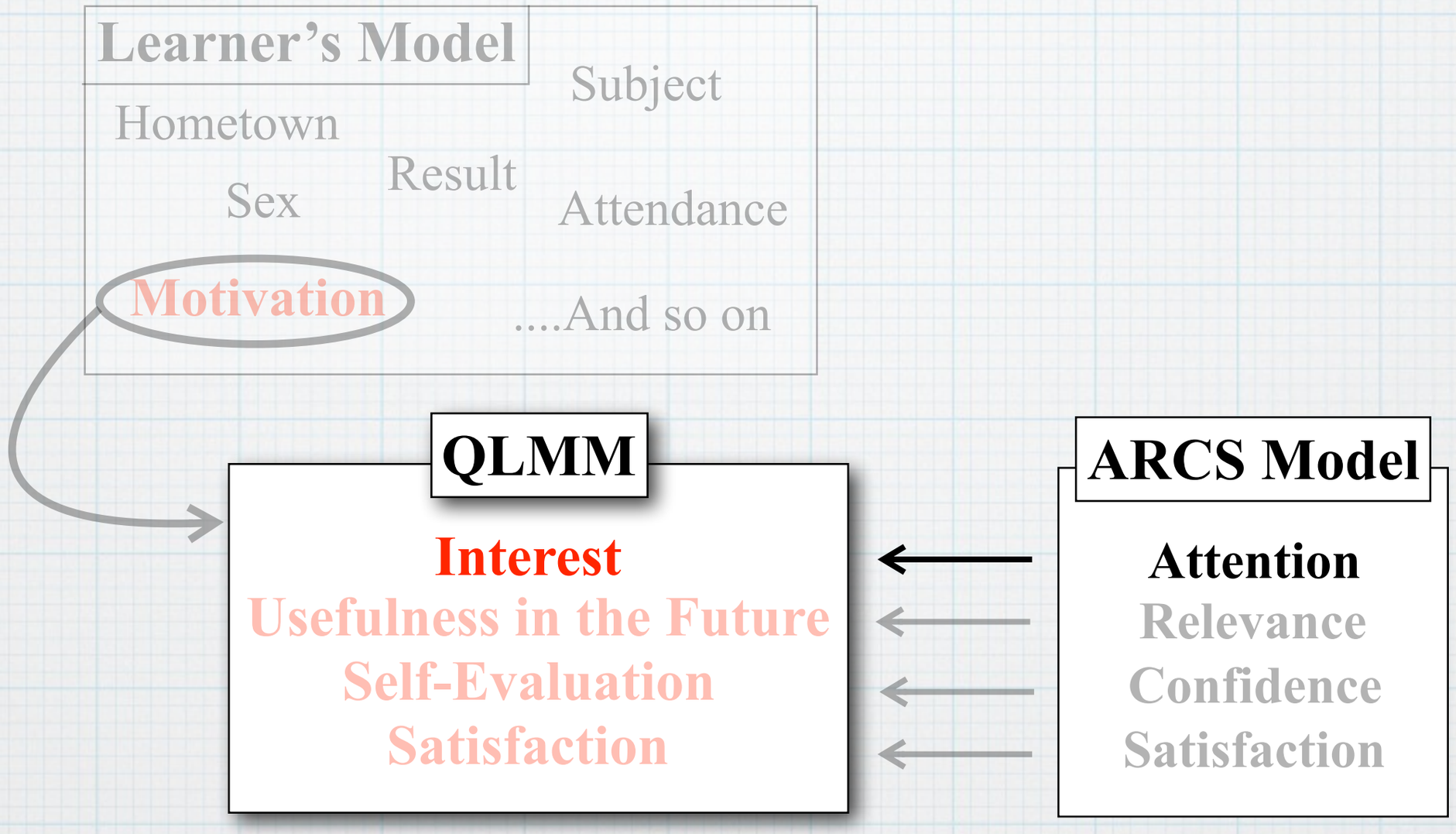


Figure .1. Relationship of QLMM and ARCS model

Quantitative Learner's Motivation Model (QLMM)



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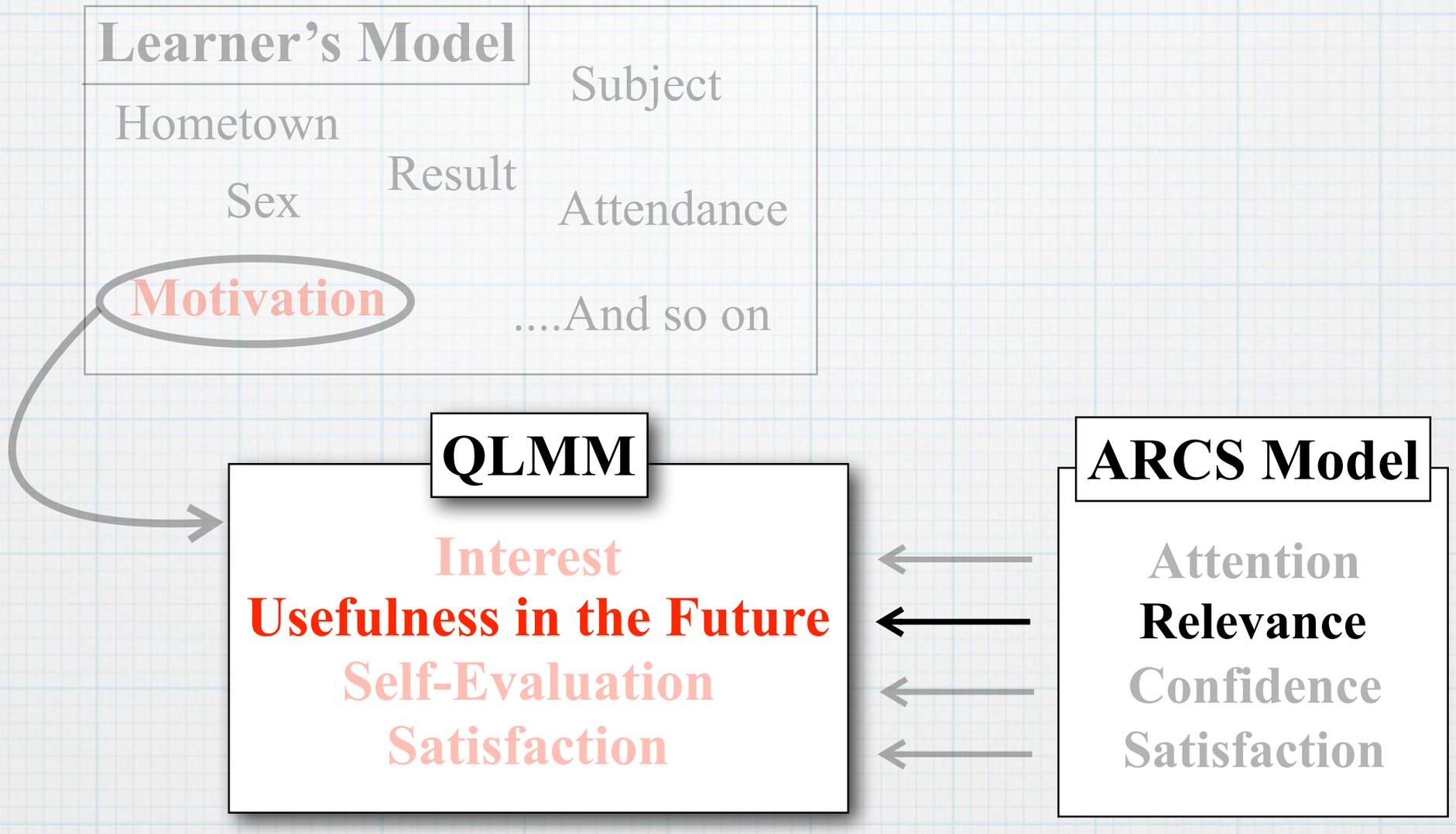

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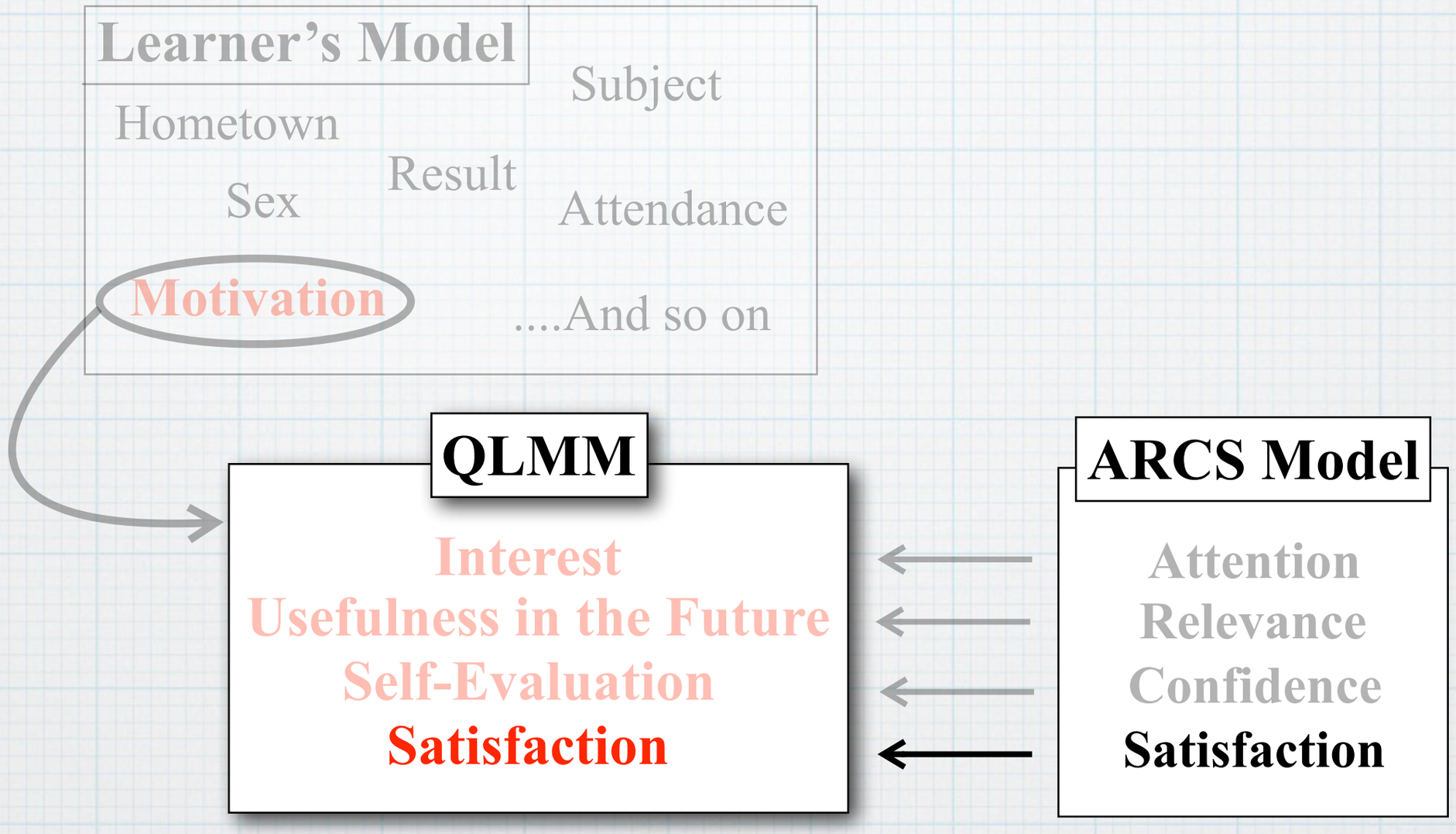


Figure .1. Relationship of QLMM and ARCS model

Questionnaire Design Based on QLMM

Designed an original questionnaire

- **For purpose of estimation of learning motivation**
- Ten questions,
  four choice-questions
  six free answer-question

→ Inquire about four elements on the basis of the ARCS model

Questionnaire Design Based on QLMM

(1) **Did you have an interest in this course?**

(2) **Do you think participating in this course will help you in the future?**

(3) **Were you satisfied with this course?**

(4) **Did you attend this course with a desire to learn?**

Figure .2. Question examples from the questionnaire

- Answers in the questionnaire were designed as choice fields **(with 5-point scale)**

→ **This allows quantification of each element**

Questionnaire Design Based on QLMM

(1) **Did you have an interest in this course?**

(2) **Do you think participating in this course will help you in the future?**

(3) **Were you satisfied with this course?**

(4) **Did you attend this course with a desire to learn?**

Figure .2. Question examples from the questionnaire

→ Applied the term of ``Confidence'' from the ARCS model

Questionnaire Design Based on QLMM

- Conduct similar questionnaire
  at the beginning and at the end of the course

→ **Assumption: Learning motivation changes**
with progress of class material

▼

- Check the transition by comparing the quantified motivation
  at each time point

Experiment: Predict the motivation of learners

- Using answers collected from the questionnaire
  performed

Questionnaire Design Based on QLMM

Prediction procedure

$$Q = \{q_1, q_2, \ldots, q_i \ldots, q_m\}$$

$$X = \{x_1, x_2, \ldots, x_j, \ldots, x_n\}$$

Q

X student group containing

Step 1.

mean average

$$\mu_i = \frac{1}{n} \sum_{j=1}^{n} r_{i,j} \quad (1)$$

standard deviation

$${\sigma_i}^2 = \frac{1}{n-1} \sum_{i=1}^{n} r_{i,j} - \mu_i \quad (2)$$

$r_{i,j}$

Questionnaire Design Based on QLMM

Prediction procedure

Step 2.

$$s_{i,j} = \begin{cases} 1 & if\ r_{i,j} \geq \mu_i \pm \sigma_i \\ -1 & if\ r_{i,j} \leq \mu_i \pm \sigma_i \\ 0 & otherwise \end{cases} \quad (3)$$

$$M_j = \sum_{i=1}^{m} s_{i,j} \quad (4)$$

Questionnaire Design Based on QLMM

Prediction procedure

Step 3.

$$Learner's\ motivation\ is \begin{cases} high & if\ M_j \geq\ \ 1 \\ low & if\ M_j \leq -1 \\ neither\ high\ nor\ low & otherwise \end{cases} \quad (5)$$

$\boldsymbol{M}$ $\{M_j \mid M_j \leq \mid m \mid,\ M_j \in Z\}$

Evaluation of Proposed Model

Carried out a questionnaire for nine courses

- Included both compulsory and elective courses
  offered to undergraduates of 1st to 3rd year
- Conducted the questionnaires
  at the beginning and at the end of the course
- Obtained a total of 5,040 answers

Attempt to automatically predict student's learning motivation

Evaluation of Proposed Model

Performed the Evaluation Experiment

- Verify the validity of the predicted learning motivation

Evaluation criteria

$$P = \frac{n}{A} \quad (6) \qquad R = \frac{n}{B} \quad (7)$$

***n**: Number of predictions based on three elements matching self-evaluation*

***A**: Number of all responses predicted using three elements*

***B**: Number of all responses inferred by self-evaluation of learners*

$$F = \frac{2 * P * R}{P + R} \quad (8)$$

Evaluation of Proposed Model

Table 1

Evaluation results

Learner's Motivation	Precision	Recall	F-measure
Low Motivation	$0.45 \pm 0.22 S.D.$	$0.88 \pm 0.12 S.D.$	$0.57 \pm 0.20 S.D.$
Neither	$0.96 \pm 0.05 S.D.$	$0.58 \pm 0.20 S.D.$	$0.70 \pm 0.16 S.D.$
High Motivation	$0.44 \pm 0.16 S.D.$	$0.89 \pm 0.15 S.D.$	$0.57 \pm 0.17 S.D.$
All	0.62	0.78	0.61

Fisher's exact test

p = 3.61e

→ **Results of the classification are statistically significant**

Discussion

- Prediction ``Neither high nor low" was easier than other classes

- Examined in detail the responses

→ **The number selected by learner indicated to**

→ **In some of the learners the perception of numerical values was subjective**

Discussion

To solve this problem

- Add two classes

  ``Slightly low motivation"

  ``Slightly high motivation"

- **Re-examine the combination of scores for each class**

Discussion

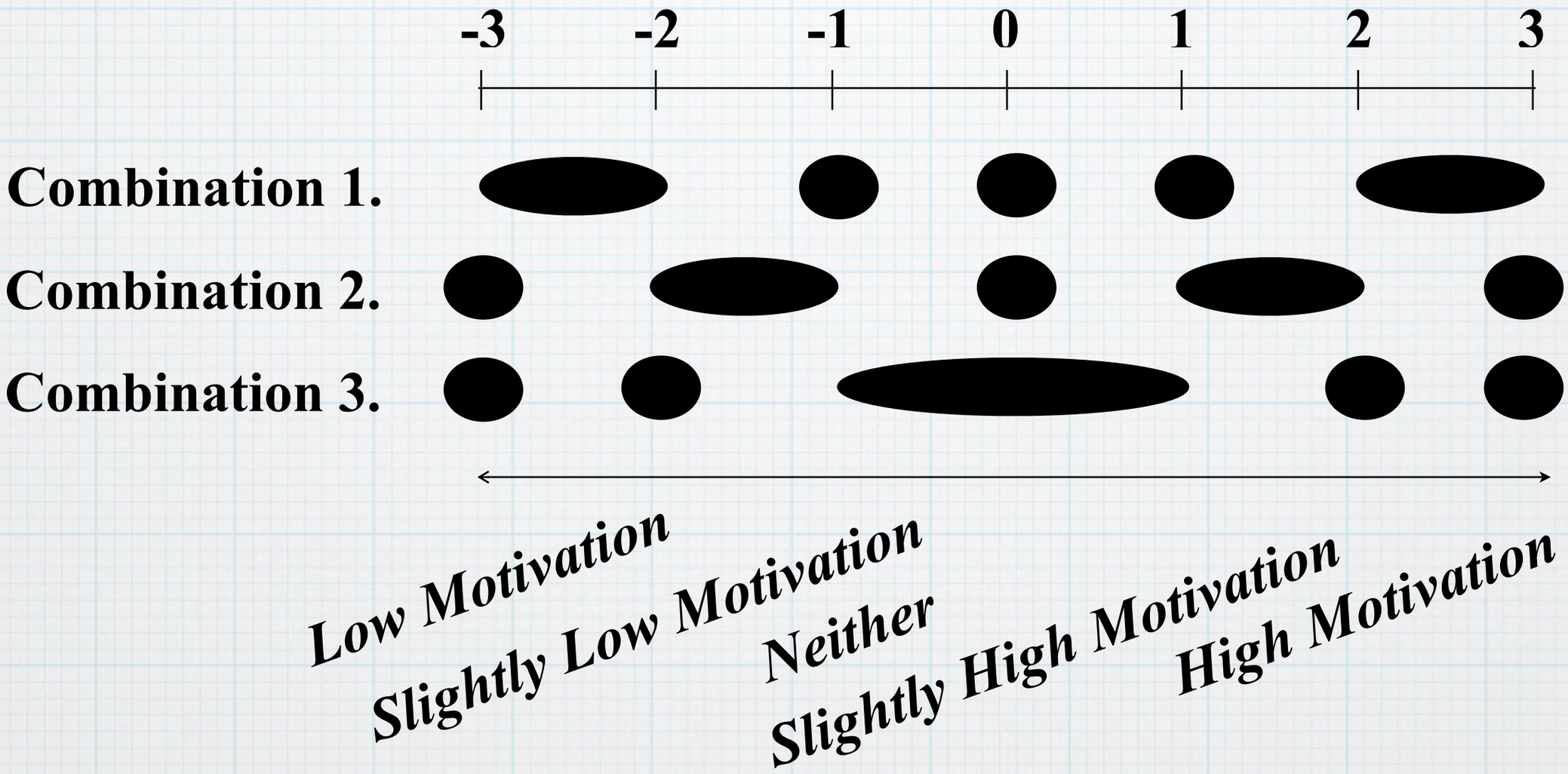


Figure .3. Possible score combinations applicable for different classes

Discussion

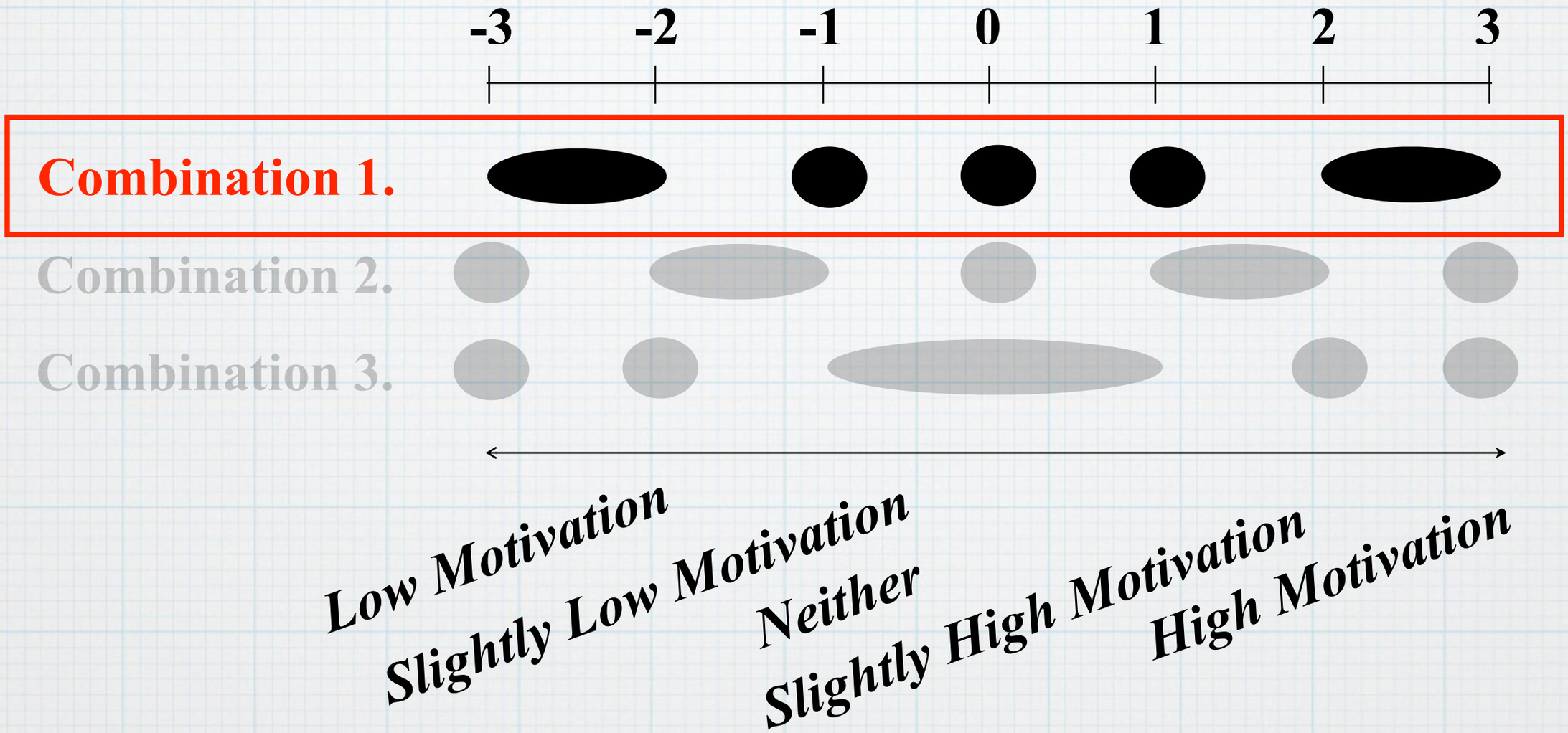


Figure .3. Possible score combinations applicable for different classes

Conclusion

- Proposed an original

(QLMM)

→ Quantification of three elements
represent the general level of learning motivation

(1)

(2)

(3)

- From result of Fisher's exact test

→ Results of classification were statistically significant

Future work

- Increase the number of classes from three to five
- Re-examine the scores depending on different combinations of classes

Questionnaire Result

	Number of Student	Number of respondents	collect rate
Course A	74	73	98.6%
Course B	63	62	98.4%
Course C	70	66	94.3%
Course D	69	64	92.8%
Course E	75	68	90.7%
Course F	181	160	88.4%
Course G	54	44	81.5%
Course H	75	58	77.3%
Course I	108	55	50.3%

Calculate Example

Predict learner's motivation

- Number of questions is three

$$Q = \{q_1, q_2, q_3\}$$

$$X = \{x_1, x_2, x_3, x_4, x_5\}$$

- Obtained values for evaluated items for each learner:

$$\{r_{1,j}, r_{2,j}, r_{3,j}\} = \{(5,1,4,3,4), (5,1,4,2,3), (4,2,3,1,2)\}$$

- $r_{i,j}$

mean average $\{\mu_1, \mu_2, \mu_3\} = \{3.4, 3.0, 2.4\}$

standard deviation $\{\sigma_1, \sigma_2, \sigma_3\} = \{1.52, 1.58, 1.14\}$

Calculate Example

Predict learner's motivation

- In this case:

learners x_1 obtains $\{s_{1,1}, s_{2,1}, s_{3,1}\} = \{1, 1, 1\}$ and $M_1 = 3$

▼

Indicates that the learning motivation in learner x_1 is "high"

Fisher's exact test

Whether there is a statistically significant association between the two groups

▼

When it is significantly related:

$$p < \alpha$$

Fisher's exact test

- *3*3*

Number of predictions based on three elements

Number of inferred by self-evaluation

	Low Motivation	Neither	High Motivation
Low Motivation	55	88	1
Neither	7	230	6
High Motivation	2	71	66

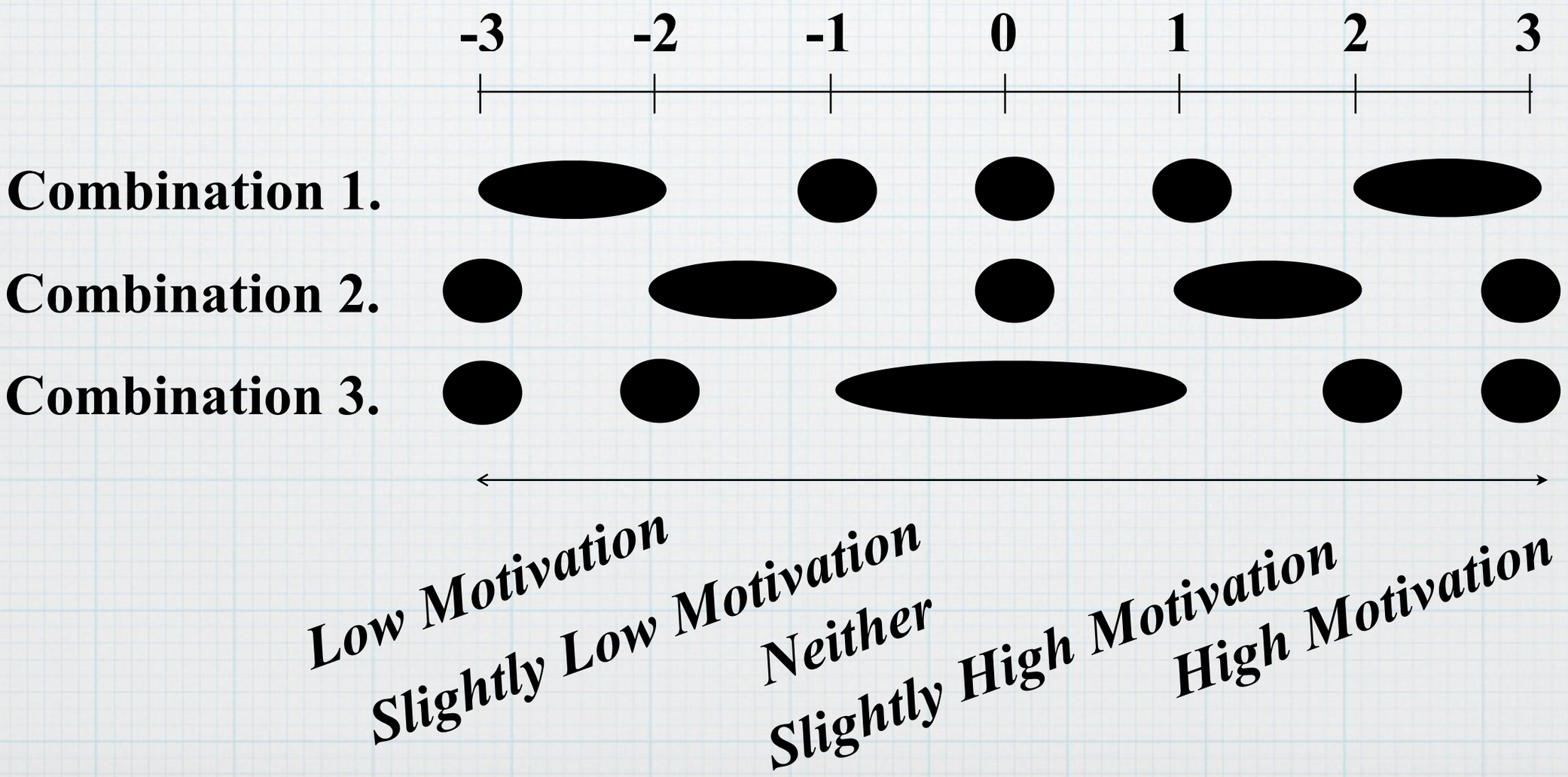
Fisher's exact test

- ***Result of each course:***

Course	p-value
Course A	2.12E-09
Course B	5E-14
Course C	5.22E-02
Course D	4.72E-05
Course E	4.21E-07
Course F	1.44E-07
Course G	1.24E-03
Course H	1.94E-07
Course I	1.97E-07

Re-examine result

	Precision	Recall	F-measure
Combination1	0.41±0.14 S.D.	0.43±0.19 S.D.	0.52±0.26 S.D.
Combination2	0.40±0.07 S.D.	0.39±0.15 S.D.	0.35±0.08 S.D.
Combination3	0.44±0.24 S.D.	0.41±0.17 S.D.	0.42±0.15 S.D.
All	0.42	0.41	0.43



Re-examine result

- ***Combination1 result:***

	Precision	Recall	F-measure
Low Motivation	0.17±0.29 S.D.	0.17±0.29 S.D.	0.17±0.29 S.D.
Slightly Low Motivation	0.21±0.26 S.D.	0.47±0.41 S.D.	0.26±0.29 S.D.
Neither	0.41±0.10 S.D.	0.47±0.36 S.D.	0.42±0.20 S.D.
Slightly High Motivation	0.60±0.20 S.D.	0.22±0.03 S.D.	0.48±0.01 S.D.
High Motivation	0.77±0.15 S.D.	0.81±0.25 S.D.	0.76±0.13 S.D.
All	0.43	0.43	0.42

Re-examine result

- ***Combination2***

	Precision	Recall	F-measure
Low Motivation	0.11±0.19 S.D.	0.17±0.29 S.D.	0.13±0.23 S.D.
Slightly Low Motivation	0.14±0.17 S.D.	0.17±0.17 S.D.	0.15±0.17 S.D.
Neither	0.41±0.10 S.D.	0.47±0.36 S.D.	0.42±0.20 S.D.
Slightly High Motivation	0.62±0.16 S.D.	0.17±0.07 S.D.	0.25±0.09 S.D.
High Motivation	0.70±0.24 S.D.	0.93±0.12 S.D.	0.77±0.18 S.D.
All	0.40	0.38	0.40

Re-examine result

- ***Combination3 result:***

	Precision	Recall	F-measure
Low Motivation	0.17±0.29 S.D.	0.17±0.29 S.D.	0.17±0.29 S.D.
Slightly Low Motivation	0.38±0.54 S.D.	0.33±0.29 S.D.	0.30±0.34 S.D.
Neither	0.44±0.10 S.D.	0.69±0.23 S.D.	0.53±0.12 S.D.
Slightly High Motivation	0.44±0.51 S.D.	0.06±0.05 S.D.	0.10±0.09 S.D.
High Motivation	0.77±0.16 S.D.	0.82±0.23 S.D.	0.77±0.12 S.D.
All	0.44	0.41	0.37