Understanding In-class Experiences of Mathematically Weak Students

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Abstract

Much research about classrooms has focused on what teachers do and their reflections about critical events in their lessons. Comparatively rare are studies that look at how students react to the many incidents and activities that take place during lessons. Students' perceptions about lesson events form an important but often neglected source of data that can be used to understand the impacts of teaching on learning. This paper reports on some findings of the feelings and thinking of mathematically weak students during mathematics lessons. Four teachers, two from primary (P4) and two from secondary (S1) schools, taught a series of four to six lessons that covered a topic in their scheme of work. During each lesson, the teachers stopped the lesson after some time and administered to their students a one-page in-class reflection checklist about that segment of the lesson. At the same time, the teacher completed a similar reflection checklist from her perspective. This in-class reflection asked students about the purpose and importance of that segment of the lesson, their feelings, and what they were doing. The teachers were able to complete two in-class reflections in most lessons. At the end of the lesson, two target students and the teacher were interviewed about these reflections. The quantitative and qualitative data were analyzed to discover similarities and differences in teacher and student perceptions and patterns of responses intra- and inter-lessons. A practical implication is that the teacher can use this simple in-class reflection checklist to obtain information about student responses to the lesson to guide planning of subsequent lessons.

Introduction

Classroom research can focus on three inter-related aspects: instructional events and tasks; teacher's intentions and behaviours; and students' perceptions and behaviours. Data are often collected about these three aspects separately, and data analyses seldom consider them together. This is due to the complexity of the many incidents and activities that take place in most classrooms. Any attempts to study the links between any two or all three aspects will advance our understanding of the nature of classroom life, with potential to explain students' outcomes in both the cognitive and affective domains.

There are few studies about students' in-class experience, especially in mathematics. In a study about Australian matriculation students, Wong (1985) examined the incongruence between students' perceived teaching activities and preferred teaching activities in mathematics lessons. This incongruence correlated negatively with mathematics scores. Bell, Curst, Shannon and Swan (1993) examined students' awareness of the types and purposes of mathematics tasks and the different ways of working with these tasks. Using questionnaires and tests, they found "a quite close agreement between the teacher's perceptions and the students' perceptions which seems to falls [sic] off as lessons become more open, less familiar and as a greater proportion of higher level skills become involved" (p. 6-12). This mismatch could be bridged after the students had undergone intensive intervention involving metacognitive activities such as "students constructing concept maps" and "students as assessors". In a more recent study, Shimizu (2002) reported the discrepancies in perceptions of classroom events between the teacher and the students. A typical Japanese lesson that teaches mathematical concepts through problem solving processes and discussion is structured around a climax ("yamaba" in Japanese). However, this "yamaba" was perceived differently, and in some instances not at all, by the students. Hence, the teacher and the students may construct different meanings of the same classroom events. Thus, a thoughtful teacher will try to discover the in-class experiences of the students and use this information to organize classroom activities that can facilitate effective learning.

While the students are engaged in an instructional activity, many thoughts pass through their mind and various feelings (enchantment, boredom, surprise, etc.) are triggered in their consciousness. These states include cognitive and metacognitive events, feelings, and interactions with other people. These streams of mental states and feelings are illustrated in Figure 1.

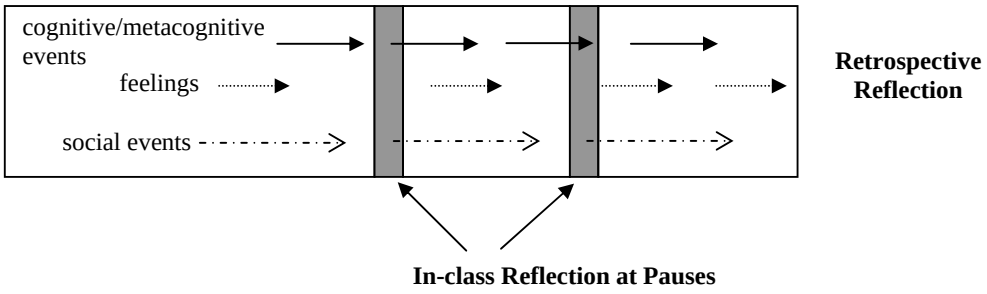

Figure 1. In-Class Reflections and Retrospective Reflection (from Wong, 2000).

Since the teacher has to pay attention to many things that happen during a typical lesson, it is not easy for them to obtain such in-class information about the students. Several techniques have been used to obtain a glimpse of these events and feelings. One such technique, which evolves from the alternative assessment movement, is to require students to keep journals about their learning, using prompts about how they feel about the lessons. Similarly, teachers who take part in action research or classroom inquiry are asked to keep a research diary about critical incidents in their lessons, their thoughts and feelings. Videotaping of the teacher and target students is used quite frequently nowadays in classroom research. Selected segments of the videotaped lessons are played back to the teacher and target students to elicit information about what they were thinking at that part of the lesson (Fedele, 1996; Garner, 1988; Peterson, Swing, Braverman, & Buss, 1982). These techniques are called retrospective reflection because the reflection takes place some time after the target activity (for example, solving a mathematics problem or listening to an explanation) was already over. The journal writing or stimulated interview may capture what the teacher or students *rationalise* about their mental states and events rather than what actually arise in their consciousness at that particular moment in the lesson.

A different approach, called in-class reflection by Wong (2000), is shown in Figure 1. It requires the students to write brief reflections of their mental states at pauses specifically chosen during the course of a lesson. These in-class reflections serve several functions. For the teacher, the pauses should be planned carefully to indicate important changes in the pedagogical flow of the lesson. For the students, the pauses indicate the end of significant trains of thought and give them some time to take stock of what they have learnt, to anticipate what to come, to touch base with their feelings, to write down a question that needs to be answered, and so on. Writing these things down, however briefly, helps them to gain metacognitive awareness of their learning. For this study, instead of asking the students to write freely, a checklist was used. This was deemed to be easier to administer and analyse for primary and lower secondary school students. In addition, a parallel checklist was designed for the teacher to complete. These checklists were collected at the end of each lesson and analysed. This technique is an adaptation of the Experience Sampling Method developed by Csikszentmihalyi (1997).

Research Questions

This study is part of a funded project that examines the learning experience of mathematically weak students. The focus is on the students rather than the teachers. It attempts to answer the following three research questions:

1. What types of mathematics lesson events do students pay attention to?
2. What are students' cognitive and affective perceptions of the classroom events and activities in mathematics lessons? These perceptions cover feelings, attention, and objectives of the lessons.
3. To what extent do students' perceptions of in-class experience match or differ from their teacher's perceptions?

The findings reported below provide some tentative answers to these questions, but a fuller picture will have to wait until more analyses are conducted on the data.

Procedure

In May 2004, two primary school teachers (P4) and two secondary school teachers (S1), all from different schools, were recruited to participate in this study. They were asked to nominate a class of mathematically weak students, usually from the lower band in primary level and the Normal stream in secondary level. The teachers met with the research team to discuss the objectives of the study and the questionnaires to be used. The student questionnaire consists of 11 items. The first 8 items required students to rate on a 6-point Likert scale (Strongly Disagree to Strongly Agree) whether they pay attention, understand the lesson, and feel excited about the lesson; see details in Table 1.

Item 9 lists the following 14 activities, and the students were asked to select one or two activities they were doing during that part of the lesson.

1.	Working on math worksheet by myself.	9.	Doing math activities in a group.
2.	Day dreaming.	10.	Doing corrections of my mistakes.
3.	Copying notes from the teacher.	11.	Taking part in questions and answers.
4.	Talking to my friends about other things (not math).	12.	Waiting for the teacher to come around to help me.
5.	Paying attention to what the teacher was saying.	13.	Doing math exercises from textbook/workbook by myself.
6.	Talking to my friends about math.	14.	Copying my friends' answers.
7.	Watching other students do work on the board.	15.	Others (please describe):
8.	Reading or looking up information in the handout or book.		

Item 10 asked students to choose one or two items from the following list of nine purposes for that part of the lesson. These purposes are more generic than some of the specific items such as "to practise multiplying quickly and accurately" and "to get better at describing shapes" used in the study by Bell et al. (1993).

1.	Revise what we had learnt.	6.	Learn new skills through practice.
2.	Learn to write about math.	7.	Think better in math.
3.	Use math in my everyday life.	8.	Enjoy doing math.
4.	Learn to talk about math with friends.	9.	Use computer or calculator to solve math problems.
5.	Develop the skills to work with others in small groups.	10.	Others (please describe):

Item 11 was for students to write down one thing they still do not understand. Unfortunately, most students did not write anything for this item, probably because of the lack of time to do a deeper reflection. The teacher questionnaire consists of similar questions as for the student questionnaire, but the items ask about teacher's perceptions; for example, instead of "I did not pay attention during this part of the lesson", the teacher rated "I felt that the students were not paying attention during this part of the lesson".

The teachers modified their normal lesson plans by adding to each lesson two or three times (called pauses) to administer the student questionnaire and to answer the teacher questionnaire. This took place for a series of four or five lessons that the teachers normally took to cover a particular topic. A research assistant observed the lessons, took notes of key incidents, and paid special attention to two target students (selected by the teachers) about their behaviours in class. The purpose of the observations was to gain an insight into the events that the teacher and students might be responding to for the in-class reflection. As soon as possible after each lesson was over, the research assistant interviewed the teacher and the target students about their responses to selected items of the questionnaire. The interviews would provide clarification about some of the responses to the questionnaire.

The study was conducted in September 2004. Nineteen lessons were observed; 38 student interviews and 18 teacher interviews were conducted. The quantitative data were analysed by schools and the findings were discussed with the teachers at a meeting in October 2004. They commented that the in-class reflections required extra curriculum time, thus increasing the time required to teach the topic. They expressed mixed responses about the benefits of these in-class reflections. Only one teacher mentioned about continuing with this technique, perhaps not so intensive as on a daily basis.

Results of a Particular Reflection

The data are still being analysed. The first step is to develop case studies of in-class reflection that deal with different mathematics topics at different levels. What follows is such a case study of a lesson on equivalent fractions taught by a female primary school teacher for a P4 lower band class. This gives a flavour of the findings from a single reflection. For this lesson, the interviews were carried out the following day as the research assistant had to rush off to another school after observing this lesson. The interviews with S1 (a Malay girl) and S2 (a Chinese boy) were carried out in the afternoon after their oral examinations. S1 came in with a friend. The interview with S1 was quite brief because S2 was waiting for his turn nearby.

Classroom Observation

This was lesson two of a series of four observed lessons on fractions. This lesson was conducted after the students had watched a skit on healthy eating in the school hall. The main objective of the lesson was for students to identify equivalent fractions of ½ and $^{1}/_{3}$. One page of the students' booklets showed fraction strips, from one whole to 12 equal parts; see sample in Figure 2 later. The students were instructed to track the dotted line (indicating halves) in the second strip down to other strips. They had to colour those strips that had this dotted line (marking the strip in halves). At this stage, one student said he did not understand and the instruction was repeated. The teacher then instructed the students to work in groups of four and stated that they were to colour all equivalent fractions of half. They were also to write down the fraction of each individual part within each strip. Most students, including the two target students, S1 and S2, were observed to be looking to the front, and writing in their worksheets. S1 turned her chair around to work with the students behind her desk. Some interactions among them were noted. S2 formed a group with two students in front of him and interacted with them briefly. This was about 10 minutes into the lesson, and the teacher asked the class to do reflection 1.

Class Results for Reflection 1

Table 1 below shows the results for Reflection 1. The students had mixed responses to this part of the lesson. However, in general, there was close agreement (with a difference less than 1, taken arbitrarily to indicate some disagreement) between the class means and the teacher scores on six of the eight items. There are two items (#2 and #6) with difference greater than 1; they are about paying attention and understanding the work. These are further discussed below.

Table 1
Reflection 1 (Items 1 to 8)

	Items	1	2	3	4	5	6	S1	S2	Mn	Tr
2.*	I did **not pay attention** during this part of the lesson.	25	8		2	1		4	1	**1.50**	**3**
1.	This part of the lesson was very **important** to me.		2	2	9	12	11	5	2	4.78	5
7.	I learnt **a lot** of math during this part of the lesson.	2	3	5	4	10	11	3	6	4.43	5
4.*	I found this part of the lesson very **difficult** to understand.	13	13	2	2	3	3	4	1	2.39	3
6.	I could **understand** this part of the lesson.	4	3	2	1	9	17	3	6	**4.64**	**3**
3.	I was **happy** with this part of the lesson.	1	3	1	4	10	17	5	6	4.94	5
5.*	I was **bored** during this part of the lesson.	24	3	1	1	5	2	3	1	2.06	2
8.	I was **excited** about this part of the lesson.	3	2	3	5	5	18	4	5	4.69	4

Notes: * indicates negative item. Scoring: 1 = Strongly disagree; 6 = Strongly agree. Mn = Class mean; Tr = Teacher rating.

Purposes of this Part of the Lesson

On the purpose of this part of the lesson, 17 students (47%) ticked "Revise what we had learnt", 7 ticked "Learn to write about math", 6 ticked "Learn new skills through practice", and the rest on the other items. The teacher ticked "Revise what they had learnt" and "Use math in their everyday life". Hence, there was general agreement that this part of the lesson was a revision of the previous lesson, although a few students thought this activity was new to them.

Paying Attention

Teachers would like their students to pay full attention in class. Table 1 shows that most of the students, including S2 but not so for S1, *disagreed* that they did *not* pay attention. Results from item 9 show that 14

students (40%) ticked "Paying attention to what the teacher was saying" as their first choice and another 6 students ticked this as second choice. Twelve students (one third) ticked "Working on math worksheet by myself" as the first choice, and this can be construed as following teacher instruction. The teacher ticked "Working on math worksheet" as the main activity for this part of the lesson. Hence, in general, the class was quite attentive and followed the teacher instruction. The teacher said at the interview:

> A lot of them were very good. I see that they're actually paying attention. They were able to sort of follow my instructions and … although at first, you know, you had this boy Simon, he put up his hand, he said he didn't understand. He's a bit … slow (…) so I may just have to repeat and clarify and make it even simpler for him.

This incidence of having to repeat the instruction in a simpler way might have prompted the teacher to rate item 2 less positive than the class mean (teacher score 3 versus class mean 1.50 on a negative item; see Table 1).

Understanding this Part of the Lesson

Many students tend to relate paying attention to understanding of the lesson. The teacher felt that her students probably did not understand it well, with score 3, lower than the student mean (4.64). The majority of the students reported that they could understand this part of the lesson, with a few reported not understanding. According to the teacher,

> Walking around, I can see, most of them, they are able to colour the equivalent fractions of half. But there are some, of course, they went on to colour one-ninth. They went to colour one-third and one-fifth. These are the students who still do not have the concepts. Out of 36, I would say, about three or four of them…

Several students, including S1 and S2, were observed to erase their work in the worksheet when the teacher discussed the answers. The interview with the teacher continues:

T: These are the really, really weak ones. There's one boy, that Roslan, he's the really weak one. He can't even read. … Way back from Primary One, he can't read anything.
I: Ok, so these are the ones that [would] not [be] able to identify [equivalent fractions].
T: They would not be able to identify.
I: Ok, and even when they were sitting in groups of four?
T: They may … just copy, right? But when you asked them to do it on their own, they would just colour any of the fraction without knowing why they have to colour it.

The teacher believed that the fraction strip could be a visual aid to help her weaker students learn.

> [The fraction strip] is something visual (…) for them, to actually check whether they actually know [equivalent fractions]. OK, based on the fraction strip, they were told to write this out. So it actually helped them. For those who already know, they actually don't need the fraction strip to help them to write it out, equivalent fractions of half. So maybe, for the weaker ones, it would just reinforce what they ought to know.

S1's Understanding of this Part of the Lesson

S1 did not have positive experience about this part of the lesson. At the interview conducted the following day, she said that she remembered "a bit" of the previous lesson. She explained that the class had to follow the dotted line (indicating half) down the other fraction strips. When asked what was similar about the strips with $^1/_2$, $^1/_4$ and $^1/_6$ parts, she replied that they had "the same length".

I: They are all the same length and then what about the parts in the strip?
S1: Different.
I: Hm? Different. Can you tell me what are the parts?
S1: What? Oh the parts ah. It's half. This is two quarters, three-sixths, five-tenths, five-twelfths eh… six-twelfths.

She reported that she asked her group members how to write and colour the fractions in some of the strips. She made the mistake of labelling the last four strips: $^1/_7$ for $^1/_8$; $^1/_8$ for $^1/_9$; $^1/_9$ for $^1/_{10}$; $^1/_{10}$ for $^1/_{12}$. She later wrote the correct fractions over the wrong ones with a darker pencil; see Figure 2.

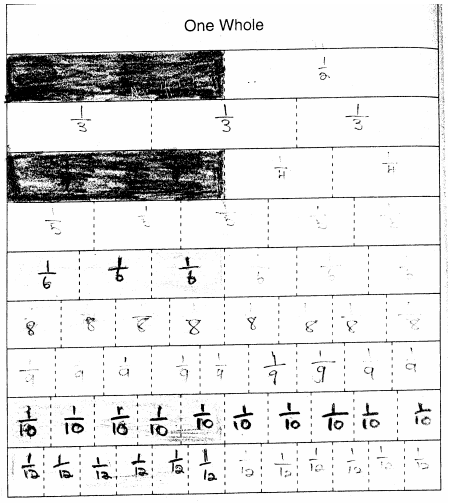

Figure 2. Fraction Strips Exercise (S1).

When asked "what is the teacher trying to teach you?", S1 could not answer. Even when prompted, she was not able to elaborate on what is an equivalent fraction.

I: What do you think? Don't know? Did you all learn equivalent fraction?
S1: Yes
I: So what does equivalent fraction mean?
S1: Equivalent

The above analysis suggests that S1 did not have a good understanding of this part of the lesson, which was consistent with her self-report about not quite understanding the lesson. This provides some validity check of her response to the written reflection.

S2's Understanding of this Part of the Lesson

In the questionnaire, S2 reported very positive responses to this part of the lesson, strongly *disagreed* that he was *not* paying attention and strongly agreed that he understood this part of the lesson. However, his worksheet showed the same errors made by S1, writing $^1/_8$, $^1/_9$, and $^1/_{10}$ for $^1/_9$, $^1/_{10}$, and $^1/_{12}$ respectively. See Figure 3.

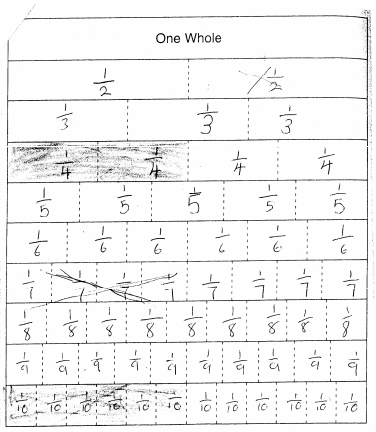

Figure 3. Fraction Strips Exercise (S2).

When asked about why he crossed out the $^1/_7$ parts, S2 replied that he had accidentally coloured it.

I: Was it you didn't understand the instructions or you didn't hear clearly or you…
S2: I didn't hear clearly.
I: So you colour then you realise you made a mistake. Ok.

When queried about his feelings during this part of the lesson, S2 reported that he felt confused and did the wrong thing because he was working too fast.

S2: Sometimes I colour wrong. I count wrong.
I: Ok. How does that happen? Can you tell me why does that happen?
S2: I count too fast. I colour too fast.

He accounted for the mistake to having not heard the instructions clearly and working too fast, rather than to poor attention or lack of understanding. He was asked to reproduce the fraction strips (1, $^1/_2$, $^1/_3$, $^1/_4$, $^1/_5$, $^1/_6$, $^1/_7$, $^1/_8$) using pencil and ruler on another piece of paper. His answer in Figure 4 was correct, showing that he had understood this part about equivalent fractions.

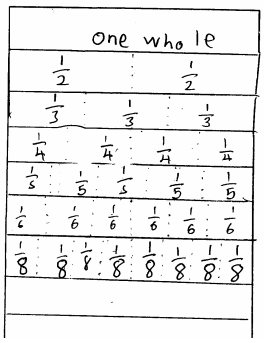

Figure 4. Fraction Strips Exercise; Free Drawing at Interview (S2).

The exchange further explored his understanding about half, which slowly emerged through some scaffolding.

I: What else is the same as half?
S2: This one (pointed to strip of four parts).
I: This one (as S2 pointed to strip of 6 parts), this one (as S2 pointed to strip of 8 parts) and what is so special about them? For example, this one (strip of four parts). Half is the same as?
S2: one-fourth [*An initial error, focusing on one strip. He used* one-fourth *rather than* one quarter.]
I: How many one-fourths is the same as half?
S2: Two [*Correct*]
I: What else? You see the dotted line down to six parts and then what is the same as half?
S2: Three
I: Three out of?… Three times of what?
S2: Six(th) [*Seems to know the meaning, though could not express it clearly.*]

The ability to express mathematical ideas clearly is not well developed in S2. Nevertheless, S2 was quite articulate in saying things like the lesson helped him to "learn how to do fraction in counting method" [count the parts in the strip], "to follow the dotted line", "to follow the half", and that the teacher was trying to show them "how to divide from one whole to half". However, he did not use the term *equivalent fraction* at the interview.

To summarise, the above case description has provided some tentative answers to the three research questions. As a class, the students reported paying some attention to the teacher and worked on the worksheet as instructed. The task of shading equivalent fractions of half on the fraction strips, probably a revision one, was not fully understood, and the teacher sensed that this was so for some of her weaker students. Students' feeling about this part of the lesson as a whole was moderately positive. Other case descriptions of these in-class reflections will also blend together psychological findings with the mathematics involved.

Results of 4 Observed Lessons

A quantitative analysis of the four observed lessons is shown in Table 2. Unlike Table 1, the three negative items (#2, 4, 5) were reversed scored and higher means in Table 2 indicate more positive experience. In general, the students tended to rate themselves slightly higher than the teacher about being attentive in class. Both the students and teacher agreed the lessons were quite important, though not so important during the last part of the final observation (L4R2). The students did not seem to indicate they had learned a lot, though they found the later lessons becoming easier (L4R1 and L4R2). The most number of disagreement between students' and teacher's perceptions occurred for item 6, whether they had understood the lessons (5 out of 8 reflections). With subsequent lessons, the teacher thought that her students did not quite understand the lesson whereas the students indicated that they did understand quite well. On the affective domain (#3, 5, 8), the students were quite positive, but the teacher thought otherwise, especially for the later lessons. It is not clear at this stage the reasons for the more noticeable discrepancies between teacher and student perceptions in the reflections for the later lessons.

Table 2
Experience of Lessons (Items 1 to 8; 6-point Likert scale)

		L1R1	L1R2	L2R1	L2R2	L3R1	L3R2	L4R1	L4R2
2* (Attentive)	S	5.35	5.35	**5.5**	5.42	5.72	5.63	5.49	**5.37**
	T	6	6	**4**	5	5	5	5	**4**
1 (Important)	S	5.21	5.00	4.78	4.67	**4.97**	4.75	5.03	4.60
	T	5	5	5	5	**6**	5	5	4
7 (Learn a lot)	S	5.03	4.29	4.43	4.72	4.75	4.86	**4.49**	4.49
	T	5	5	5	5	5	4	**3**	4
4* (Easy)	S	4.39	**3.91**	4.61	5.00	5.44	5.11	5.41	**5.26**
	T	5	**6**	4	5	5	5	5	**4**
6 (Understand)	S	5.18	4.87	**4.64**	**5.11**	5.31	**5.47**	**5.29**	**5.14**
	T	6	5	**3**	**3**	5	**4**	**3**	**4**
3 (Happy)	S	5.03	5.06	4.94	5.03	5.26	4.86	4.66	**5.00**
	T	5	5	5	5	5	5	4	**4**
5* (Note bored)	S	**5.21**	4.29	4.94	4.86	4.89	**5.00**	**5.11**	**5.26**
	T	**4**	5	5	5	5	**3**	**4**	**4**
8 (Excited)	S	5.26	4.65	4.69	4.83	4.92	**5.06**	**5.09**	**5.29**
	T	5	5	4	5	5	**4**	**4**	**4**

Concluding Remarks

This preliminary analysis has shown that the methodology of in-class reflection supported by subsequent interviews can produce rich data about students' experience of mathematics learning in the classrooms. The teacher and students (as a class) seem to share similar experience, but individual differences can be quite great. These differences could have significant impacts on the learning of the individual students, as in the case of S1 and S2 above. It is not easy for the teachers to take into consideration these differences when they continue their lesson. The in-class reflection is one useful tool to provide the teacher with the time to reflect on certain parts of the lesson when the students are also doing so. The teachers in this study had commented on the extra curriculum time required to do these reflections. Subsequent analyses of the data might shed some light on whether the benefits of these reflections could justify the perceived "loss" of curriculum time, as the teachers often feel the pressure to "cover" the syllabus.

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