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Students' self-assessment predictors and practices in an undergraduate mathematics course

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In this study, we investigated students' self-assessment practices and predictive dispositions. The participants (N = 280) were undergraduate students who practised self-assessment during a first-year mathematics course. For the final summative assessment method, the students could choose between self-grading and exam. We analysed how students' self-assessment predictors and practices changed during the course and how the changes were linked to the students' choice of final assessment method. Our results show that students' attitudes towards self-assessment, self-assessment efficacy belief and their intention to self-assess improved during the course. Self-assessment practices changed from seeking external to relying more on internal feedback. In the self-grading group, self-assessment predictors shifted to a more positive direction than in the exam group.

Keywords: Undergraduate mathematics, self-assessment, student-centred assessment.

Introduction

Student self-assessment is a powerful and versatile assessment method that aims at not only evaluating students' skills, but also at enhancing their learning. When used properly, self-assessment promotes academic performance (Brown & Harris, 2013) and metacognitive skills (Panadero et al., 2016). It can be used to teach and evaluate skills that are otherwise difficult to measure, such as appreciating quality of work (Tai et al, 2018) and various transferable skills, such as communication, teamwork and identity building (Rämö et al., 2023).

This exploratory report is part of a larger study, which aims to promote student agency in mathematics by teaching the students self-assessment skills and by allowing them to choose their own course assessment method between self-grading and a traditional end exam (e.g., Rämö et al., 2022). The self-grading is not aimed at a particular piece of work but is instead based on a rubric of learning objectives (Häsä et al., 2021). Promoting alternative assessment methods is particularly important in mathematics since exams dominate assessment in mathematics heavily (e.g., Iannone & Simpson, 2022).

In this report, we looked at several attitudinal variables that have been found to predict students' intention and willingness to perform self-assessment (Yan et al., 2020). We also looked at variables that give insight to students' practices while they are performing self-assessment (Yan, 2018). Our research questions were:

1. How do students' self-assessment predictors and practices change during an undergraduate mathematics course specially designed to promote self-assessment?

2. How do self-assessment predictors and practices differ between students who prefer self-grading and students who prefer end exam?

This study has several novel approaches. Firstly, self-assessment methods in mathematics often focus on students evaluating their own course work against given marking criteria. However, in our approach, the students are evaluating their skills directly against learning objectives, using course work only as evidence of attained skills. Secondly, the study delves into *how* and *why* students would do self-assessment, instead of simply reporting the results of such an experiment. Thirdly, the study aims to give freedom to the students to choose their own assessment method in order to elicit genuine information about their behaviour and preferences.

Self-assessment predictors and practices

Self-assessment practices that are meaningful to learning are not simply self-rating or grade guessing. They are complex learning processes in which students seek and use feedback from various sources and evaluate and reflect on their learning performance against selected criteria, with the purpose of improving learning (Panadero et al., 2016). Yan and Brown (2017) proposed and empirically demonstrated a self-assessment process model which encompasses three primary actions: determining assessment criteria, self-directed feedback seeking, and self-reflection.

Studies on predictors of students' self-assessment practices (i.e., why do students conduct self-assessment) are limited. As explicit and structured self-assessment in classrooms is a personal endeavour that requires volitional effort, students' intentions to self-assess should strongly influence the actual self-assessment practices (Ajzen, 1991). This relationship has been verified in empirical studies. Yan et al. (2020) found that students' intentions to self-assess were influenced by their attitude toward self-assessment, subjective norms, perceived behavioural control on self-assessment, psychological safety, and self-efficacy. Self-efficacy refers to a person's belief in their capability to accomplish a certain task (Bandura, 1977). Yan et al. (2020) also found that in addition to driving the intention to self-assess, psychological safety and, in particular, self-efficacy directly supported self-assessment practices. In addition to personal attributes, pedagogical factors, such as clear assessment criteria and sufficient training, may also facilitate self-assessment (Brown & Harris, 2013).

There are also other studies that have focused on students' perceptions and intentions towards self-assessment. Hill (2016) studied accounting students' perceptions towards self-assessment and found that most students did not perform self-assessment voluntarily, but when the self-assessment process was facilitated for them, they started to perceive it positively. In a previous part of the current project, Rämö et al. (2022) studied students' perceptions of self-assessment in the context of university mathematics. They found that students who chose self-assessment instead of exam justified their choice most often with enhanced learning gains and flexibility. On the other hand, students who chose the exam, also thought it would help them learn better. Some of the students had negative experiences and emotions towards self-assessment and therefore chose the exam.

Context

The context of the study was a first-year undergraduate course in linear algebra in a research-intensive Finnish university. The course lasted for 7 weeks and was worth 5 ECTS credits. The course had 376

students who came from different backgrounds. The most common major subjects among students were mathematics and mathematics education, computer science, economy and statistics. The teaching of the course utilised the inquiry-based Extreme Apprenticeship method (Rämö et al., 2021). Students started studying new topics by working on introductory tasks and reading the course material. The tasks provided them automatic, instant feedback. Then the topics were discussed in the lectures which focused on building the big picture and linking together different concepts. After the lectures, the students deepened their understanding by completing more demanding tasks. Every week one of these tasks was assessed by teachers. An open learning space was available for the students where they could work collaboratively with their peers and receive support from teachers.

During the course, students practised self-assessment following the DISA model (Häsä et al., 2021). The students completed two self-assessment exercises in which they assessed their competencies using a detailed learning objectives matrix created by the teacher. The students were asked to give themselves a grade in every topic mentioned in the matrix and justify the grade in writing. The students received automated feedback on the accuracy of their assessments based on the coursework they had completed during the course. Examples of students' justifications were discussed in the lectures, and the teacher explained what characterises a good justification.

For the summative assessment that took place at the end of the course, students could choose from two options: exam and self-grading. If a student chose the exam, their grade was determined by the exam together with bonus points received from weekly tasks. The students who chose self-grading assessed their competencies according to the DISA model, and the self-assessments were checked against the tasks they had completed during the course. The teacher could step in if the self-assessment was not in line with the coursework the student had completed. The students had to choose the summative assessment method in the beginning of the course, but they could change their choice before the end of the course. In the beginning of the course, 306 of the students chose self-grading and 70 chose the examination. There were 18 students who changed their choice from examination to self-grading and 5 from self-grading to examination.

Method

The participants in this study are students who participated in the focus course of this study. The data consists of a pre-survey to which students answered in the beginning of the course and a post-survey which students completed at the end of the course. Students' answers were gathered via the Moodle platform that was used for teaching the course. The 280 (74%) students who responded to both pre- and post-questionnaires and gave consent to use their answers were included in the study.

Students' self-assessment practices were assessed with the Self-assessment Practice Scale (SaPS) (Yan, 2018). This instrument has four subscales corresponding to the four self-assessment actions, including *seeking external feedback through inquiry*, *seeking external feedback through monitoring*, *seeking internal feedback*, and *self-reflection*. Self-assessment predictors were measured with six scales developed by Yan et al. (2020). These include *instrumental* and *affective attitude* towards self-assessment, *psychological safety*, *subjective norms*, *self-efficacy belief*, and *intention* to conduct self-assessment. The instrument was translated into Finnish by one of the authors. To make the questionnaire shorter and compatible with the Finnish university context, some questions were

discarded (e.g., “I believe the principal of my school wants all students to self-assess”). Table 1 lists abbreviations, number of items, observed Cronbach alpha reliabilities and example items for all the scales. All items had a six-point Likert-type response scale ranging from 1 (Strongly disagree) to 6 (Strongly agree).

Table 1: The ten self-assessment predictors and practices measured in this study

Scale	Abbreviation	No of items	Cronbach α pre/post	Example item
Predictors				
Instrumental attitude	IAT	6	.88/.89	Self-assessment helps me learn more efficiently.
Affective attitude	AAT	3	.87/.92	I like self-assessment.
Psychological safety	PSY	4	.51/.57	Honest self-assessment brings me negative consequences.
Subjective norms	SNS	3	.59/.70	I believe my teachers want me to do self-assessment.
Self-efficacy	SEF	4	.69/.65	I know how to implement self-assessment.
Intention	INT	4	.84/.88	I willingly assess myself.
Practices				
Feedback through inquiry	SFI	3	.69/.75	I ask my friends to tell me how to improve my learning.
Feedback through monitoring	SFM	3	.43 / .45	I check my performance against the answers in textbooks or on websites.
Internal feedback	SIF	3	.56/.67	My intuition tells me if I am doing a good job or not.
Self-reflection	SER	3	.55/.65	As I study, I think whether the way I am studying is really helping me learn

Main analyses were conducted with R software. To measure the difference between pre- and post-tests in students’ self-assessment predictors and practices, we performed a Student’s paired-sample *t*-test for each of the ten variables. The relationship of students’ choice of assessment method and their self-assessment predictors and practices was measured with independent samples *t*-tests. These

t-tests were done using the Welch approximation to account for unequal variances. In both cases, normality of residuals was tested for each attitude variable by examining histograms and quantile-quantile plots. Good levels of normality were observed for all variables except for SNS, SEF, INT, SFM and SIF in the exam group. However, the normality was considered reasonable for using *t*-test also for these variables. Statistical correction for multiple testing was done with the Holm method.

Results

To assess the change in self-assessment predictors and practices between the beginning and the end of the course, ten paired-sample *t*-tests were performed. The results are shown in Table 2. In five of the variables, a significant increase was detected. Instrumental attitude (IAT), Self-efficacy (SEF), Intention (INT) and Internal feedback (SIF) increased from the pre-test to the post-test. The only variable for which a significant decrease was detected was Feedback through monitoring (SFM). After the Holm correction, only the changes in SEF, INT and SIF were statistically significant.

Table 2. Summary of *t*-test results for the change of students' self-assessment predictors and practices during the course (N=280)

Variable	Abbreviation	Pre-test		Post-test		<i>t</i>	<i>p</i>	Holm corrected	Cohen's <i>d</i>
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>				
Instrumental attitude	IAT	4.08	0.90	4.19	0.94	2.34	.02	.12	0.12
Affective attitude	AAT	3.23	1.15	3.28	1.26	0.92	.36	.90	0.04
Psychological safety	PSY	2.53	0.79	2.47	0.84	-1.53	.13	.51	-0.08
Subjective norms	SNS	4.65	0.82	4.25	0.91	1.78	.08	.38	0.09
Self-efficacy	SEF	4.32	0.79	4.52	0.73	5.07	< .001	< .001	0.26
Intention	INT	3.14	1.03	3.32	1.14	3.67	< .001	.003	0.17
Feedback through inquiry	SFI	2.86	1.02	2.90	1.08	0.86	.39	.90	0.04
Feedback through monitoring	SFM	3.81	0.91	3.69	0.98	-2.47	.01	.10	-0.13
Internal feedback	SIF	4.21	0.78	4.36	0.83	3.26	.001	.01	0.18
Self-reflection	SER	4.66	0.74	4.71	0.79	1.04	.30	.90	0.06

Next, we investigated if the change in predictors and practices differed between the students who chose self-grading and those who chose the exam. This was done with ten independent samples *t*-tests. The results are shown in Table 3. For four of the variables, the change in the self-grading group was significantly different from the exam group. In the self-grading group, the change in Affective

attitude (AAT), Subjective norms (SNS), and Intention (INT) was positive and greater than in the exam group. After the Holm correction the changes for none of the variables were statistically significant.

Table 3. Summary of Welch’s t-test results for the change of students’ self-assessment predictors and practices during the course between the self-grading and exam groups

Variable	Self-grading (n = 238)		Exam (n = 42)		<i>t</i>	Welch <i>df</i>	<i>p</i>	Holm corrected	Cohen’s <i>d</i>
	M	SD	M	SD					
IAT	0.15	0.80	-0.07	0.86	1.53	54.36	.13	.66	0.26
AAT	0.11	0.92	-0.27	0.94	2.47	56.01	.02	.13	0.42
PSY	-0.08	0.72	0.02	0.60	-1.00	64.19	.32	1.00	-0.16
SNS	0.13	0.76	-0.18	0.72	2.56	58.29	.01	.12	0.42
SEF	0.23	0.66	0.04	0.62	1.18	58.86	.08	.49	0.29
INT	0.24	0.83	-0.13	0.83	2.62	56.48	.01	.11	0.44
SFI	0.05	0.81	0.02	0.86	0.21	54.34	.83	1.00	0.04
SFM	-0.10	0.80	-0.25	0.88	1.08	53.57	.29	1.00	0.17
SIF	0.15	0.74	0.13	0.75	0.16	55.94	.87	1.00	0.03
SER	0.08	0.68	-0.16	0.74	1.93	53.66	.06	.41	0.33

Discussion

In this study, we investigated how students’ self-assessment predictors and practices changed during a first-year undergraduate course in which students practised self-assessment. Of the predictors, Self-efficacy, Intention, and Instrumental attitude increased during the course. This indicates that in the end of the course the students felt that they were more able to assess themselves, were more willing to conduct self-assessment, and saw more value in self-assessment than in the beginning of the course.

Yan et al. (2020) have shown that Self-efficacy is one of the most important predictors of students’ self-assessment practices. Hence it is crucial to develop students’ self-efficacy for self-assessment in order to improve their practices, and it seems that in our context the learning environment managed to do this. Also, the increase in Intention is a positive sign, as according to Yan et al. (2020), many self-assessment predictors affect self-assessment practices via Intention. The increase in self-efficacy could be due to the self-assessment exercises done during the course, since mastery experience is a

source of self-efficacy (Usher & Pajares, 2009). Also, the feedback the students received on their self-assessments may have influenced self-efficacy (see Brown & Harris, 2014), as well as the detailed learning objective matrix which was used in structuring the self-assessment exercises.

Of the self-assessment practices, Internal feedback increased and Feedback through monitoring decreased. In other words, the students reported using more intuition and gut feeling in self-assessment than before and monitored less their performance against sources such as past exams and model solutions. This can indicate that the students learned to trust their intuition as they had had chances to calibrate it against feedback, or alternatively they became overconfident and wanted to avoid the extra work in monitoring their performance.

The students could choose between two final assessment methods: self-grading and exam. We investigated if there was a difference in how the self-assessment predictors and practices changed in these two groups during the course. In the self-grading group, Affective attitude, Subjective norms, and Intention increased more than in the exam group. One explanation is that expecting a particular final assessment method had an effect on how students' dispositions towards self-assessment shaped during the course. Another option is that the students who chose self-grading had a different propensity for development from the ones choosing the exam.

It should be noted that the results of this study are tentative. After correcting for multiple testing, the changes for the whole population in Instrumental attitude and Feedback through monitoring were not statistically significant. Similarly, none of the differences for the self-grading and exam groups were statistically significant after correcting for multiple testing. In addition, some of the variables had a low reliability score.

The results of this study suggest that students' perceptions of self-assessment can improve, and students' practices can change when they engage with self-assessment. Further investigation is needed in confirming these preliminary results and determining what is the role of the learning environment and the final assessment method.

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