RESEARCH ARTICLE

Pharmacy students' and supervisors' perceptions of the effectiveness of assessment rubrics for undergraduate research performance review

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Abstract

Background: Research experience in pharmacy education fosters critical thinking, communication, and research skills; thus, it is crucial to ensure that research skills are acquired and research outcomes are achieved. **Objective:** This study aimed to evaluate students' and supervisors' perceptions of the effectiveness of assessment rubrics in measuring and enhancing student research performance. **Methods:** Two surveys were administered separately to research supervisors and students to collect information on their perceptions of the effectiveness of assessment rubrics. **Results:** Most supervisors agreed that assessment rubrics made scoring easier, accurate, unbiased, and consistent (>72% rated ≥4) and that they helped identify the strengths and weaknesses of their students in research (73.3% rated ≥4). About 80.5% of students ranked the rubrics ≥4, indicating that rubrics motivated them to improve their research performance. Essentially, the effective use of assessment rubrics to improve research performance would depend on students' attitudes towards self-regulation and supervisors' commitment to project supervision.

Introduction

Research exposure has been reported to enrich the learning experience of undergraduate students of various programmes, including pharmacy (Tan, 2007; Lee *et al.,* 2010; Laidlaw *et al.,* 2012; Harirforoosh & Stewart, 2016; Bhagavathula *et al.,* 2017). The research experience enhances students' understanding of research and allows them to discover their research interests where they can further pursue graduate studies and, subsequently, a career as a researcher (Lopatto, 2007; Murdoch-Eaton *et al.,* 2010; Tan *et al.,* 2020). Indeed, scholarly activities might raise students' interest in pursuing academic pharmacy as their profession (Nykamp *et al.,* 2010). Furthermore, by undertaking a research project, students could develop teamwork, critical thinking, problem-solving, lifelong learning, and oral and written communication skills; they could also build their self-confidence and play a

more active role in their own learning (Lopatto, 2007; Petrella & Jung, 2008; Tan *et al.,* 2020). Undergraduate research experience also provides an opportunity for students to acquire knowledge on scientific investigation, project management, and research ethics, as well as to participate in various research activities such as method design, the conduct of research, scientific observations, data collection, data analysis, and data interpretation (Laidlaw *et al.,* 2012; Bhagavathula *et al.,* 2017; Perez, Rabionet & Bleidt, 2017). These research skills and attributes are crucial for healthcare professionals (Laidlaw *et al.,* 2012). In evidence-based medicine, healthcare professionals are required to provide the best care and treatment plans for their patients based on the available evidence. They should have a certain understanding of research and how the evidence is obtained to provide critical judgement (Laidlaw *et al.,* 2012; Cailor *et al.,* 2017). Thus, research experience focused on developing

research skills is essential in training pharmacy students because it enables to generate new research ideas and apply existing research to enhance patient care (Deal *et al.,* 2016). Nevertheless, providing undergraduate research experience can be challenging, particularly when trying to accomodate a large number of students. These challenges include human resources, managing research projects, procuring necessary resources, and finding experienced faculty members to supervise undergraduate research students (Murphy *et al.,* 2007).

The present study was conducted at the International Medical University (IMU), a private institution in Malaysia that offers the Bachelor of Pharmacy (Hons) programme, a four-year undergraduate programme accredited by the Malaysian Pharmacy Board and the Malaysian Qualifications Agency (MQA). This programme provides a comprehensive education in pharmacy and prepares students for practising in hospitals, community settings, and pharmaceutical industries; it incorporates research training to equip students with the necessary skills to conduct research effectively. The research project modules are the core modules in the final year of the IMU BPharm (Hons) programme. Once a research project had been selected, students and their respective supervisors had to defend the research proposal before the IMU Joint Committee on Research and Ethics (IMU-JC) prior to starting the research project. Upon approval, students could start their research activities, including literature review, data collection, and data analysis, and then present their research findings orally and in a written dissertation. All these research activities had to be completed within the 16 weeks of the research term. Students were guided and supported by research supervisors who played crucial roles in cultivating research attitudes, providing guidance and support, and ensuring student progress and research productivity (Houser, Lemmons & Cahill, 2013; Davis & Jones, 2017; Maharajan *et al.,* 2017). Furthermore, supervisors were responsible for monitoring student progress in the research project, evaluating their research performance, and providing feedback for improvement. Thus, in the research project module, assessment rubrics were used by supervisors to assess student progress, research skills, and attitudes and provide feedback for improvement. These assessment rubrics were designed to articulate the research expectations by stating the assessment criteria and describing levels of performance related to each criterion (Jonsson & Svingby, 2007; Panadero & Jonsson, 2013; Halonen *et al.,* 2016).

Generally, a well-designed assessment rubric should provide detailed scoring guides for evaluating performance, notifying students of their progress, and

motivating their learning and development (Halonen *et al.,* 2016). It also increases the transparency in scoring, facilitates the feedback process to students, and improves student self-regulation (Andrade & Du, 2005; Jonsson, 2014; Panadero & Jonsson, 2013). From the assessor's perspective, a rubric helps streamline the assessment, eases the grading process, makes scoring more accurate, unbiased, and consistent, and improves the feedback process (Allen & Tanner, 2006; Panadero & Jonsson, 2013). Assessment rubrics clarify the standards for performance levels to both supervisors and students, making them useful for monitoring and enhancing performance (Allen & Tanner, 2006). Therefore, this study aimed to determine students' and supervisors' perceptions of the effectiveness of assessment rubrics in measuring and enhancing student research performance. It also sought to identify the correlation between supervisors' grading and students' self-evaluation with their respective survey responses and demographic factors.

Methods

Research progress evaluation

In the undergraduate pharmacy programme at IMU, 60% of the research project module assessment is based on student research progress evaluation by supervisors. The Research Handbook provides all information related to the module, including assessment rubrics. Research supervisors used these rubrics to evaluate student performance in research conduct, project execution and management, data analysis, and interpretation, in addition to their attitudes and professionalism. Research progress was monitored in three stages, *i.e.* weeks 7, 11, and 16, with increasing weight age (10%, 20%, and 30%, respectively) to provide opportunities for student improvement based on feedback from the supervisor.

Assessment rubrics

The assessment rubrics used in the three stages had several criteria in common, including (i) conduct of research activities, (ii) active participation, timeliness, and punctuality in research discussion, and (iii) professionalism. At the first stage of progress review, students' understanding of the study design was evaluated. Their applicable skills were assessed in the second stage while performance in data analysis and interpretation was evaluated at the final stage. All criteria were categorised into four groups: excellent, good, satisfactory, and weak (Appendix A).

Study design

In 2019, feedback was sought from final-year undergraduate IMU pharmacy students undertaking research and their supervisors to get information on the use of assessment rubrics in measuring and enhancing student research performance. Participation of both students and supervisors was voluntary. Feedback was obtained using online questionnaires after the completion of all the research progress assessments. Both student and supervisor questionnaires included demographic information and questions on the general perception of the assessment rubrics and the effectiveness of these rubrics for feedback and student improvement. Most questions were rated on a 5-point Likert scale from strongly disagree (Rank 1) to strongly agree (Rank 5). There were also open-ended questions to solicit students' and supervisors' perceptions of the assessment rubrics and feedback for student improvement in research skills. Furthermore, students were asked to self-evaluate their conduct of research activities, execution, and management of their research projects as well as their skills in data analysis and interpretation.

The IMU-JC approved this project (IMU430/2019).

Supervisor survey

For the supervisor survey, demographic information was collected, including affiliation (School of Pharmacy/ School of Medicine/School of Dentistry/ School of Health Sciences/Institute of Research, Development, and Innovation (IRDI)), designation (Professor/Associate Professor/senior lecturer/lecturer), years involved in research (post-PhD), information about the supervised research project (laboratory-based or non-laboratory-based research projects, local or international research projects), and the number of pharmacy research students. Supervisors were also asked to rank their interest in research from 1 (least interested) to 5 (very interested). Three questions were included to gather supervisors' perceptions of the use of rubrics as assessment tools: whether rubrics enhanced the understanding of the assessment criteria and made scoring easier, accurate, unbiased, and consistent. Four questions focused on the use of assessment rubrics for feedback (importance of providing feedback for students' progress in research and whether the rubrics helped provide feedback and identify students' weaknesses and strengths in research).

Student survey

For the student survey, demographic information was collected, including pre-university education, laboratory-based or non-laboratory-based research projects, local

or international research projects, and affiliation of the principal supervisor (School of Pharmacy/School of Medicine/School of Dentistry/School of Health Sciences/IRDI). Respondents were also asked to state their preference of the current research project (first choice/second choice/third choice/not at all), rate their interest in research (from 1 = least interested to 5 = very interested), and whether they had read the Research Handbook and the assessment rubrics. Two additional questions sought students' perceptions of the importance of assessment rubrics in providing information on the assessment criteria, while three questions focused on evaluating the use of assessment rubrics for self-reflection and self-motivation to improve the research performance among the respondents. The survey also enquired whether respondents received feedback from their respective supervisors in each progress review and whether the assessment rubrics provided fair and consistent grading of their research performance.

Focus group interview

A focus group of seven students was also recruited to provide their views on the importance of using assessment rubrics in research progress evaluation, how rubrics could help with student self-reflection and improvement, and how they motivated the students to improve. The students were also asked if rubrics could be used to provide feedback for their improvement, and suggestions for improvement were sought.

Data analysis

The Pearson Chi-square test was used to measure the correlations between students' self-evaluation and supervisors' grading of these skills with their respective demographic factors. Spearman's rank-order correlation coefficients were used to determine the correlations between students' self-evaluation and supervisors' grading with their respective responses to the survey questions.

Results

Of the 38 researchers who were involved in the supervision of pharmacy students in undergraduate research, 30 responded to the survey (response rate of 78.9%). Most respondents were affiliated with the School of Pharmacy (63.33%), followed by the School of Medicine (30%), the School of Dentistry (3.33%), and IRDI (3.33%). The respondents were professors (3.33%), associate professors (13.33%), senior lecturers (53.33%), and lecturers (30%). Eleven respondents had more than

10 years of research experience (post-PhD), while nine respondents had less than five years, seven had less than 10 years, and only two had less than one year of research experience. One respondent did not answer the question. Respondents rated 5 (53.33%), 4 (33.33%), and 3 (13.33%) their interest in research. About 70% were involved in laboratory-based research; most of these research projects were conducted at the IMU research laboratories (76.7%), while 23.3 % and 20% were conducted at other local and international institutions, respectively. The number of students supervised varied among the respondents: three or fewer (33.3%), 4-5 (56.7%), and seven or more (10%).

Of the 129 pharmacy students who conducted research projects, only 78 responded to the survey (response rate of 60.46%). Their pre-university educational backgrounds were A-Levels (55%), the IMU Foundation in Science Programme (28%), and the Malaysian Higher School Certificate (commonly known in Malay as "Sijil Tinggi Persekolahan Malaysia" or STPM, 8%). Moreover, 73.3% conducted laboratory-based research projects, while 26.7% were involved in non-laboratory-based research projects. Some respondents were attached to research projects in other local (11.5%) and international (12.8%) institutions. Their principal supervisors were

mainly affiliated with the School of Pharmacy (62.8%), followed by the School of Medicine (16.7%), and the School of Health Sciences (11.5%). Most respondents obtained the project of their first (82%) or second choice (11%). The respondents rated 5 (30.8%), 4 (44.9%), 3 (16.7%), 2 (3.8%), and 1 (3.8%) their interest in research. All respondents except one reported having read the Research Handbook.

Based on the 5-point Likert scale from strongly disagree (Rank 1) to strongly agree (Rank 5), 93.6% rated more than 4 when asked about the importance of knowing the assessment criteria. From the students' responses to the open-ended questions, their performance improved because they were informed about the expected standards and how they would be graded through the assessment criteria. When asked whether the assessment rubrics enhanced their understanding of how they would be assessed, 82% rated ≥4, 14.1% rated 3 and 3.9% gave a rating ≤2 (Table I). Students indicated that the assessment rubrics were very helpful as they served as guidelines for assessment preparation and enabled supervisors to provide specific comments for improvement. They also declared that rubrics could enhance fairness in assessment.

Table I: Students' responses (n=78) to the survey questions

	Number of respondents (%)				
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Do you agree that it is important for you to know the assessment criteria?	1 (1.3)		4 (5.1)	31 (39.7)	42 (53.9)
Do you agree that the assessment rubrics enhance your understanding on how you would be assessed?	1 (1.3)	2 (2.6)	11 (14.1)	41 (52.6)	23 (29.4)
Do you agree that the progress assessment rubrics provide fair and consistent grading?	2 (2.6)	3 (3.8)	15 (19.2)	37 (47.4)	21 (27.0)
Do you agree that the assessment rubrics motivate you to improve your research performance? *	2 (2.5)	1 (1.3)	12 (15.4)	45 (57.7)	17 (21.8)
Do you agree that the assessment rubrics facilitate self-reflection allowing you to identify your strengths and weaknesses?	2 (2.6)	3 (3.8)	11 (14.1)	44 (56.4)	18 (23.1)
Do you agree that your supervisor provides feedback for your improvement in each progress review?	2 (2.6)	1 (1.3)	18 (23.1)	35 (44.8)	22 (28.2)

*One student did not answer the question.

Table II presents quotes from participants of the focus group. Overall, students perceived rubrics as important guidelines that allowed them to refer to the required criteria and perform accordingly.

As for supervisors, all gave a grade ≥3 when asked whether the rubrics enhanced their understanding of the assessment criteria (76.7% gave a grade ≥4) and made scoring easier (86.6% gave a grade ≥4), accurate, unbiased, and consistent (72.4% gave a grade ≥4) (Table III).

Table II: Focus group quotes

Questions	Participant quotes
1. Do you think that the progress assessment rubrics are important to you all?	"Yes, it is important because …. I can check which criterion has the highest or lowest mark." "It gave us guidelines on how we were supposed to carry out our research, …. to perform…. It is important especially to those who carried out research in different facilities…. to understand about our progress as our supervisors were not there to observe us most of the time." "…. before assessment, I looked at the criteria …which I needed to fulfil….and after assessment, I looked at my marks and those with low marks, I knew I must brush up on that."
2. Can you explain how the rubrics help you in self-reflection?	"In one… criterion, I received three instead of four, I know that in this area, I might need to improve myself." "Before the first assessment, I did not look … the aspects which were expected, …. got lower marks in the first assessment…. I checked and compared the criteria in the first and second assessment….to know what criteria to focus for each assessment." "I was doing …. not in IMU, but overseas, ….my co-supervisor was a Japanese, and my main supervisor was a Malaysia, there were different aspects and different ways of thought…. the criteria in the assessment rubric helped me to focus and improve on the aspects required."
3. How you think that these assessment rubrics motivated you?	"There were three stages …I could see my progress …. this motivated me to improve my performance …." "It encouraged me…. also depending on the student interest in the project…"
4. Do you think rubrics help to achieve fairness?	"…if compared with or without rubric, with rubric definitely was fair. Without rubric….. supervisors would… grade … based on their own understanding. With rubrics, they would stick to the actual criteria…." "Once I got my marks, I would probably ask my supervisor about my performance and then I could improve on it." "Rubric was fair... if both students achieved the same outcomes …the rubric was a good tool to measure their performance."
5. Improvement in research is based on the supervisor's feedback or own reflection based on rubrics?	"If you….in contact with supervisor, then direct conversation would be more helpful… But if you were …. not always in contact … could only depend on the rubrics and do self-reflection... depend on the communication between supervisor and student." "For me, … I just reflected on my marks based on the rubrics and improved myself." "For me… both..."
6. Any improvement or suggestions for the assessment rubrics?	"…. the rubrics were clear and transparent." "Not all supervisors provided comment for improvement…if can make it compulsory for supervisor to provide feedback in addition to the grading, it would be helpful to the students." ".. the criteria were fair and helpful."

Table III: Supervisors' responses (n=30) to the survey questions

	Number of respondents (%)				
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Do you agree that the BPharm Sem 7 progress assessment rubrics enhance your understanding of the assessment criteria?			7 (23.3)	17 (56.7)	6 (20.0)
Do you agree that the progress assessment rubrics make scoring easier?			4 (13.3)	16 (53.3)	10 (33.3)
Do you agree that the progress assessment rubrics make scoring more accurate, unbiased, and consistent?*			8 (26.7)	13 (43.3)	8 (26.7)
Do you agree that feedback is important for student progress in research?			3 (10.0)	15 (50.0)	12 (40.0)
Do you agree that you have provided feedback to your project student for his/her improvement in each progress review?			3 (10.0)	19 (63.3)	8 (26.7)
Do you agree that the progress assessment rubrics help you to identify the strengths and weaknesses of your student(s) in research?		1 (3.3)	7 (23.3)	19 (63.3)	3 (10.0)
Do you agree that the progress assessment rubrics help you in providing feedback for student improvement?			8 (26.7)	18 (60.0)	4 (13.3)

*One supervisor did not answer the question.

Table I shows that 80.5% of students gave a rating of ≥4, 15.6% gave a rating of 3, and 3.9% gave a rating of ≤2 regarding their perceptions of whether assessment rubrics motivated them to improve their research performance. Some students reported that the rubrics helped them identify areas for improvement and enabled them to improve based on feedback from their supervisors. Most students agreed that the assessment rubrics facilitated self-reflection, allowing them to identify their strengths and weaknesses (≥ 4, 79.5%; 3, 14.1%). However, 6.4% gave a rating of ≤ 2, with some students commenting that assessment rubrics did not enable them to identify their weaknesses and strengths without feedback from supervisors. One student mentioned that the supervisor provided feedback and explanations in each progress review, which considerably helped them understand their weaknesses and strengths. In the focus group interview (Table II), students explained that they could identify the criteria with lower scores and work to improve them before the next progress review. While most students agreed that assessment rubrics could enhance self-motivation, one student noted that it would also depend on the student's interest in research.

When asked whether their supervisors provided feedback for their improvement in each progress review, 28.2% of respondents gave a rating of 5, 44.8% gave a rating of 4, 23.1% gave a rating of 3, 1.3% gave a rating of 2, and 2.6% gave a rating of 1 (Table I). When asked whether feedback was important for their students' progress in research, 40% and 50% of the supervisors gave a rating of 5 and 4, respectively, while 10% gave a rating of 3 (Table III). Most supervisors agreed that they had provided feedback in each progress review (90% gave a rating of ≥4, and 10% gave a rating of 3), and some indicated that continuous feedback was provided whenever necessary as they met their project students frequently. However, when asked if assessment rubrics helped them identify the strengths and weaknesses of their students, only 10% of the supervisors gave a rating of 5, while 63.3% gave a rating of 4, 23.3% gave a rating of 3, and 3.3% gave a rating of 2. One supervisor noted that direct interaction and observation were more helpful in identifying the weaknesses and strengths of their students, and feedback was provided based on student performance. Similarly, students in the focus group also reported that direct interaction and feedback from supervisors were helpful, although they also used rubrics to conduct self-assessment and improve their work. Students suggested that all supervisors provide feedback for their project students to ensure consistent support.

Students' self-evaluation of their ability to execute and manage the research project was significantly correlated with their responses to the survey questions (Table IV) but had no significant association with the student demographic factors (Table V). Supervisors' grading of student ability to execute and manage the research project was also significantly correlated with their responses to whether they had provided feedback for student improvement in each review (Table VI). Demographic factors of supervisors were not correlated with their grading of student performance, except for designation and type of research, which were significantly associated with their grading of data analysis and interpretation skills and execution and management of research projects, respectively (Table VII).

Table IV: Spearman's rank-order correlation coefficients between students' survey responses with their self-evaluation

Student survey	Research performance evaluation		
	Conduct of research	Execution and management of research projects	Data analysis and interpretation
How do you rank your interest in research?	0.18	0.22	0.15
Do you agree that you have read the Semester 7 research handbook?	0.19	0.23 *	0.07
Do you agree that the assessment rubrics enhance your understanding on how you would be assessed?	0.05	0.04	0.13
Do you agree that it is important for you to know the assessment criteria?	0.24 *	0.29 *	0.10
Do you agree that the assessment rubrics facilitate self-reflection allowing you to identify your strengths and weaknesses?	0.22	0.26 *	0.17
Do you agree that the assessment rubrics motivate you to improve your research performance?	-0.01	0.15	0.09
Do you agree that your supervisor provides feedback for your improvement in each progress review?	0.22	0.26 *	0.16
Do you agree that the progress assessment rubrics provide fair and consistent grading?	0.19	0.24 *	0.17

* Indicates *p*<.05

Table V: Association of students' self-evaluation with their respective demographic factors

Student demographic factors	Research performance evaluation		
	Conduct of research	Execution and management of research projects	Data analysis and interpretation
*Pre-U Background	χ2=4.28, *p*=.98	χ2=8.88, *p*=.71	χ2=8.70, *p*=.73
Type of Research Project	χ2=2.52, *p*=.28	χ2=4.56, *p*=.10	χ2=2.82, *p*=.24
Where do you conduct your research project?	χ2=5.29, *p*=.73	χ2=5.61, *p*=.69	χ2=8.05, *p*=.43
**Main Supervisor Affiliation	χ2=10.95, *p*=.20	χ2=5.90, *p*=.66	χ2=7.61, *p*=.47
What is your preference for your current project?	χ2=5.54, *p*=.48	χ2=3.49, *p*=.74	χ2=2.17, *p*=.90

*Pre-U Backgroud refers to pre-university education background prior to enrolment into the IMU BPharm (Hons) programme including A-Levels, the IMU Foundation in Science Programme and the Malaysian Higher School Certificate (commonly known in Malay as "Sijil Tinggi Persekolahan Malaysia" or STPM).** Main supervisor affiliation (School of Pharmacy/ School of Medicine/ School of Dentistry/ School of Health Sciences/ IRDI).

Table VI: Spearman's rank-order correlation coefficients between supervisors' survey responses with their grading

Supervisor survey	Research performance evaluation		
	Conduct of research	Execution and management of research projects	Data analysis and interpretation
How do you rank your interest in research?	0.20	0.18	0.13
How many BPharm Semester 7 students are you supervising in 2019?	0.09	-0.05	-0.09
Do you agree that the BPharm Sem 7 progress assessment rubrics enhance your understanding of the assessment criteria?	-0.06	-0.01	-0.02
Do you agree that the progress assessment rubrics make scoring easier?	0.06	0.01	-0.07
Do you agree that the progress assessment rubrics make scoring more accurate, unbiased, and consistent?	0.04	0.05	-0.07
Do you agree that feedback is important for student progress in research?	-0.09	-0.12	-0.20
Do you agree that you have provided feedback to your project student for his/her improvement in each progress review?	0.06	0.30 *	0.18
Do you agree that the progress assessment rubrics help you to identify the strengths and weaknesses of your student(s) in research?	0.03	-0.08	0.05
Do you agree that the progress assessment rubrics help you in providing feedback for student improvement?	-0.03	-0.12	-0.03

* Indicates *p*<.05

Table VII: Association of supervisors' grading with their respective demographic factors

Supervisor demographic factors	Research performance evaluation		
	Conduct of research	Execution and management of research projects	Data analysis and interpretation
*Affiliation	χ2=2.27, *p*=.89	χ2=10.07, *p*=.12	χ2=8.81, *p*=.18
**Designation	χ2=7.37, *p*=.29	χ2=4.10, *p*=.66	χ2=17.69, *p*=.01*
Where did your student(s) conduct the research?	χ2=6.36, *p*=.78	χ2=14.63, *p*=.15	χ2=12.49, *p*=.25
Type of Research Project	χ2=0.53, *p*=.77	χ2=7.88, *p*=.02*	χ2=0.036, *p*=.98
How many years have you been involved in research (post-PhD)?	χ2=11.52, *p*=.07	χ2=3.29, *p*=.77	χ2=11.11, *p*=.08

*Affiliation (School of Pharmacy/ School of Medicine/ School of Dentistry/ School of Health Sciences/ IRDI), **designation (professor/ associate professor/ senior lecturer/ lecturer).

Discussion

This study could demonstrate the roles of assessment rubrics in helping students perceive expectations about their attitudes and research performance and in facilitating supervisors' evaluation and feedback processes. Although the research project module could provide undergraduate pharmacy students with an excellent and helpful experience to develop specific research skills and enhance their competencies and self-assurance in undertaking research work, students struggled with several challenges in their initial research exposure (Tan *et al.,* 2020). Assessment rubrics prepare students for research by providing a broad understanding of the expectations for their attitudes, research conduct, and data collection, analysis, and interpretation, while allowing for a clear and transparent evaluation of their research performance (Jonsson, 2014). The present study also unvealed the role of assessment rubrics in supporting self-evaluation, thus facilitating self-reflection and improvement in research performance and subsequently enhancing students' self-regulatory capacity (Jonsson, 2014; Balloo *et al.,* 2018). However, some students tended to focus on the assessment criteria to improve their grading; thus, it was vital to ensure that explicit assessment criteria would not impede student learning (Jönsson & Prins, 2019). Ideally, rubrics should encourage students to identify gaps in their abilities and effectively improve their weaknesses (Chowdhury, 2019).

Students' perceptions of the use of rubrics for self-reflection, the role of rubrics in providing a fair and consistent grade, and the reading of the research handbook and feedback from their supervisors showed a weak but significant association with their self-evaluation regarding their project execution and management skills. Indeed, self-efficacy could be associated with self-regulation. A study involving 200 students from six faculties at Tehran Tarbiat Moallem University revealed that self-regulation has a significant positive relationship with self-efficacy (Arabzadeh et al., 2012). Improvement in research performance could be achieved through self-regulation because the assessment criteria were clear and helpful for students to conduct self-reflection and self-evaluation. A study showed that in addition to efficacy-based self-regulation via goal-setting, the individual interest could facilitate self-regulation and, eventually, performance (Lee *et al.,* 2014). Thus, allowing students to choose the project according to their interests might positively affect self-regulation and performance. Additionally, constructive feedback from supervisors could motivate students to perform in research (Moskvicheva, Bordovskaia & Darinskaya, 2015; Agricola *et al.,* 2020). Other factors could contribute to improved research performance,

such as the supervisor's research competencies, interest in student research performance, relationship with the student, commitment to providing timely and constructive feedback, and awareness of standards expected from the student (Ismail, Abiddin & Hassan, 2011; Ali, Watson & Dhingra, 2016; Masek, 2017).

Based on the surveys in this study, assessment rubrics informed both supervisors and students on the expected standards for research projects and aided in effective supervision. Consistent with previous reports, assessment rubrics served as an effective tool for grading student progress, providing systematic feedback for improvement, and ensuring fairness in assessment (Allen & Tanner, 2006; Panadero & Jonsson, 2013). Students acknowledged that these rubrics could ensure fairness in assessment, but they noted that differences in research projects and supervisors' expectations might affect the attainment of this fairness. Indeed, demographic factors of supervisors, such as designation and type of research project, were significantly associated with their grading of student performance. Although the ideal research performance evaluation should be independent of the assessor and the type of project, this is hardly achievable (Jonsson & Svingby, 2007). However, the use of rubrics can increase the reliability of performance reviews (Silvestri & Oescher, 2006) and contribute to the transparency of assessment (Jonsson, 2014), which allows students to receive feedback from supervisors and improve their research skills (Chowdhury, 2019) before the next performance review.

Limitations

Several points regarding the present study are worth mentioning. Firstly, the study involved the IMU pharmacy students who were given a 16-week immersive experience dedicated entirely to research, during which they would receive guidance and feedback from their faculty supervisors. The performance review conducted in three stages with increasing assessment weightage might have influenced self-regulation in students as it allowed them to reflect, take practical actions, change their attitudes to achieve desirable future outcomes, such as improved research performance and better results in the next progress review. In fact, research has shown that development feedback or future-focused feedback was more effective in motivating change (Gnepp *et al.,* 2020).

Secondly, there may be potential participant bias as the study was confined to only one institution and one cohort of students. Additionally, some supervisors and students did not participate, resulting in missing data. Follow-up study could be conducted with future cohorts to determine if similar trends are observed and confirm

the effectiveness of assessment rubrics in research performance improvement.

Conclusion

In general, the surveys revealed valuable insights into the perceptions of IMU pharmacy students and their supervisors in undergraduate research. Most students conducted laboratory-based research projects, with the IMU School of Pharmacy being the primary affiliation of their supervisors. Supervisors and students perceived assessment rubrics as an essential tool that enhanced their understanding of assessment criteria, facilitated scoring, and allowed transparency in assessment. The assessment rubrics also motivated students to improve their research performance before the next progress review. Feedback from supervisors was perceived as essential for students' progress in research. Assessment rubrics could aid supervisors in identifying the strengths and weaknesses of their students and facilitate a systematic process for timely constructive feedback. These findings highlight the importance of assessment rubrics and feedback in undergraduate pharmacy research, which can lead to better learning outcomes and improved research performance.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A: Descriptors of the assessment criteria

Assessment Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Weak (1/0)
Understand the study design and rationale	• Has good understanding on the study design and rationale • Able to explain all the study's design features, indicating how the methods proposed collectively contribute to address the research question • Able to suggest improvements in the study design	• Has appropriate understanding on the study design and rationale • Able to explain some but not all the study's design features, indicating how the methods proposed collectively contribute to address the research question	• Has some understanding on the study design and rationale • Able to define the concept of the design as the collective features, such as sample characteristics, stimuli, and data collection procedures	• Has no understanding on the study design and rationale • Demonstrates virtually no knowledge of the purpose or elements of the study design
Conduct of research activities	• Good attendance to site of data collection or laboratory bench • Consistently completes research activities on time • Overcomes difficulties with courage • Very independent, takes own initiative, proposes new aspects to study	• Good attendance to site of data collection or laboratory bench • Consistently completes research activities on time • Independent and occasionally takes own initiative	• Satisfactory attendance to site of data collection or laboratory bench • Occasionally completes research activities on time • Occasionally requires help	• Poor attendance to site of data collection or laboratory bench • Loses motivation when facing difficulties • Requires help all the time, just follows instructions
Skills applicable to the research project	• Excellent in skills relevant to the research project, improves procedures, work is done with great attention to details	• Good in skills relevant to the research project, • Work is done well with one or two errors	• Satisfactory in skills relevant to the research project, • Work is done with some errors	• Fails to master skills after being taught, work is not done properly
Execution and management of research projects	• Accurately and completely carries out the steps in the project's data collection protocol. • Consistently making no mistakes in data collection • Good documentation of data • Responds appropriately to unusual circumstances such as participant deviations from instructions or equipment malfunction • Able to troubleshoot	• Accurately and completely carries out the steps in the project's data collection protocol. • Consistently making no mistakes in data collection • Good documentation of data	• Occasionally does not accurately and completely carry out the steps specified in the project's data collection protocol • Occasionally making mistakes in data collection • Satisfactory documentation of data	• Demonstrates no knowledge of the project's data collection procedures • Always making mistakes • Poor documentation of data
Data analysis and interpretation	• Able to suggest appropriate statistical and analytical methodologies for data analysis • Generates accurate results • Able to summarise study results, and answer research questions, as well as suggest implications for theory and practice.	• Accurately identifies appropriate methods to analyse data • Generates accurate results • Draws accurate conclusions from study results that are closely related to research questions	• Able to use some analytical tools to summarise research results • Able to draw logical conclusions from study results but may not be related to research questions	• Demonstrates no knowledge of data analyses • Demonstrates little or no knowledge of making logical conclusions from study results
Active participation, timeliness, and punctuality in research discussion	• Consistently participates in discussion and comes prepared • Usually punctual • Proactive, initiates or schedules appointments	• Consistently participates in discussion and comes prepared • Usually punctual	• Occasionally participates in discussion and comes prepared • Sometimes has difficulty with punctuality	• Does not make an effort to participate in discussion • Fail to keep appointments

Assessment Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Weak (1/0)
	- when necessary, frequent reporting on progress, - Work submitted in very good time or before deadline	Work submitted on time	Sometimes work submitted at the last minute	- Very little reporting on progress - Work submitted at the last minute
Professionalism	- Consistently adheres to organisation's specific working environment requirements and work ethics code, e.g., laboratory safety guidelines - Consistently demonstrates an attitude of self-respect, respect for peers and supervisors - Consistently demonstrates honesty in academic work, truthful to him/herself and others.	- Usually adheres to organisation's specific working environment requirements and work ethics code, e.g., laboratory safety guidelines - Usually demonstrates an attitude of self-respect, respect for peers and supervisors - Demonstrates honesty in academic work, truthful to him/herself and others.	- Occasionally adheres to organisation's specific working environment requirements and work ethics code, e.g., laboratory safety guidelines - Occasionally demonstrates an attitude of self-respect, respect for peers and supervisors - Demonstrates honesty in academic work; truthful to him/herself and others.	- No adherence to organisation's specific working environment requirements and work ethics code, e.g., laboratory safety guidelines - Demonstrate no attitude of self-respect, respect for peers and supervisors or - Has demonstrated academic dishonesty and has not been truthful in a consistent manner