

An Expert System for Penalty Apportioning in Cases of Examination Malpractice

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Abstract

Punishment apportioning in cases of examination malpractice in institutions of learning is often affected by biases such as gender, age, and socioeconomic status. These biases frequently lead to inconsistencies, unfairness, and injustice, thereby undermining the integrity of the examination system. Despite the existence of clear punitive guidelines for assigning penalties to erring students in most higher institutions, these guidelines are still subjectively enforced, often influenced by various biases. To mitigate this problem, it is important to develop a reliable and objective method for determining penalties for examination malpractice. This study introduces an innovative expert system that applies existing punitive knowledge and reasoning to determine penalties in a more objective and reliable manner. By adopting a consistent, rule-based approach, the system ensures fair and consistent outcomes, thus addressing the challenge of subjective human judgment. The study details the system's development process, from conceptualization to implementation. A knowledge base containing 48 rules was designed for the expert system. ES-Builder 3.0, an expert development tool, was used to build the model. Using PHP and MySQL, ES-Builder 3.0 provides a web-based Expert System Shell (ESS) that makes decisions based on a decision tree. A dataset of examination malpractice guidelines from the Federal Cooperative College, Ibadan (FCCIb) was used to evaluate the model's efficacy. The results suggest that the expert system is objective and free from bias, and it is therefore recommended for penalty apportioning in cases of examination malpractice.

1.0 Introduction

Examination malpractice refers any type of cheating and unlawful examination-related activities that provide students with grades, promotions, or higher placements that they do not deserve [1]. These offences can be either before, during or after the examination. Schools are among the organizations saddled with the responsibility of fostering citizens' moral, intellectual, behavioral and attitudinal development. These goals can be undermined by malpractice. Students who cheat often fail to acquire essential skills for future academic or professional challenges and this dishonest behaviour can persist into their careers, promoting corruption and unethical practices in society [2]. Examination malpractice exists in varying degrees in every nation of the world [3].

[4] noted that cultism, inadequate educational infrastructure, examination malpractice and a disturbed academic calendar are some of the arguments put up by those who are critical of the calibre of graduates from educational institutions. But then, they [4] argued that, among other factors, in nations like Nigeria, exam malpractice has recently gained the average status of a social, moral and educational plague that seems to defy all sorts of intervention.

Despite numerous interventions—such as the Federal Government's Decree 20 of 1984 and the establishment of disciplinary committees by educational institutions and regulatory bodies—malpractice persists. Moreover, current punishment apportionment is often influenced by gender, age, or socioeconomic biases, leading to unfair outcomes that erode system integrity.

Expert systems, or Knowledge-Based Systems (KBS), are AI applications designed to simulate human expert decision-making in specific domains [5]. They behave as an artificial advisory system for a particular problem domain. Expert systems offer objective, consistent recommendations and can mitigate human bias.

There is a need for a reliable and objective method of determining penalties for examination malpractice. The current system relies on subjective assessments by individual instructors and/or committees, which can be inconsistent and open to bias. This research is centered on developing a prototype expert system model which uses an expert development tool, ES-Builder 3.0 to develop an examination malpractice-based penalty assignment system. Using PHP and MySQL, the ES-Builder 3.0 provides a web-based ES Shell (ESS) that makes decision based on decision tree. The system leverages decision tree's algorithm to generate transparent and consistent penalty recommendations based on factors such as case establishment, offense severity and prior infractions. The system is intended to assist disciplinary committees in the decision-making process for apportioning penalties for examination malpractice within the concept of a specific institution. It provides a more objective and reliable system which is based on synthesized human knowledge and reasoning. The system is designed to be used as a tool to support decision-making, and it is not intended to replace the judgment of human experts.

The insights gained from this research could inform the development of new policies or

strategies for preventing or addressing examination malpractice.

2.0 Literature Review

Examination malpractice is a widespread issue across all educational level [6]. Misconducts during examinations in the past may not be completely ruled out, but the current tendency is concerning and necessitates appropriate management to lessen the potential repercussions on the educational system. Students now engage in malpractice openly, leading to inflated academic results and ultimately, a workforce lacking competence and confidence [1]. The likelihood of such students continuing to cheat during tests in the future is high. These problems emanate from the secondary school and university admissions procedures.

In order to address the embarrassing issue of examination malpractice in Nigeria, the Federal Military Government issued Decree 20 in 1984. The Decree prescribes a 21-year prison term for examination malpractice offenses [7]. This was later amended by Examination Malpractice Act 33 of 1999, which provided for lesser penalties, such as fines and shorter jail terms [8]. The government's poor enforcement of the regulations has led to an upsurge in examination misconduct despite all of these restrictions [9].

The prevalence of examination malpractice reduces the value of examinations and has a negative effect on them [3]. Hence, the need for an objective system to assist disciplinary committees in assigning fair penalties. The current penalty allocation methods are prone to bias based on gender, race or socioeconomic background. Additionally,

current methods may not be effective in deterring future instances of examination malpractice. The limitations and challenges of current penalty allocation methods highlight the need for more effective and equitable approaches to addressing examination malpractice. A standardized, evidence-based and context-aware approach could ensure fairer, more consistent outcomes. Such a system must consider the severity and frequency of offenses and institutional regulations.

One viable solution is the implementation of an expert system – a type of knowledge based system that encodes heuristic knowledge from domain experts to solve problems at their level of expertise [10]. These systems operate on a knowledge base and an inference engine to deliver decisions and insights in fields where human expertise is limited or inconsistent [11].

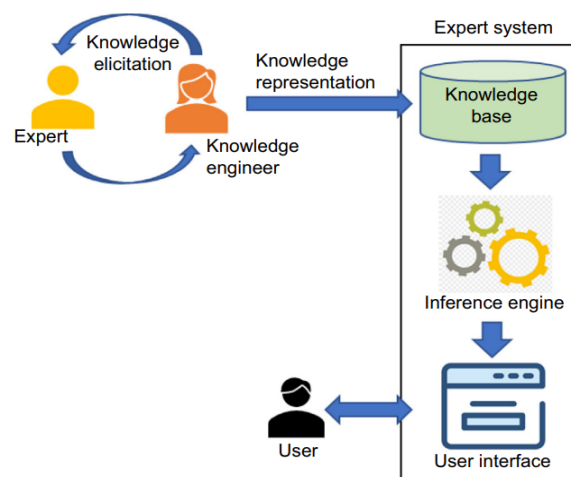


Figure 1: Schematic Representation of an Expert System [12]

As shown in Figure 1, an expert system typically consists of three components:

- A knowledge base (rules and facts),

- An inference engine (reasoning mechanism), and
- A user interface (communication layer with the end user).

The construction of a knowledge base structure is based on some specific If-Then principles gathered from specialists [13], [14]. The knowledge gained from human experts is structured to allow for effective retrieval and use during problem solving. Knowledge bases store knowledge using various knowledge representation schemes, whereas inference engines use inference rules to determine viable solutions to a given problem, thus serves as the expert system's reasoning component [15]. It employs various inference techniques, such as rule-based reasoning, pattern matching, logical deduction or probabilistic reasoning, to derive conclusions and make decisions based on the knowledge stored in the knowledge base [16], [17], [18], [19], [20]. The user interface provides end users with a way to communicate with the system, engage in interactive dialogue or provide information if necessary. The system then presents recommendations and interpretations of these recommendations [21], [12].

After the successful deployment of expert systems in 1965, it has been applied in domains where human experts are scarce, expensive or not available in real-time [24]. For example, [25] designed a rule-based expert system to support Individual Education and Therapeutic Programs (IPETs) for children with disabilities, improving consistency and efficiency. Similarly, [26] also proposed a similar system that assess teachers' competence in using Moodle and establishes how they

utilize the Learning Management System (LMS) using rule-based logic derived from expert insight. However, they depend heavily on accurate data and require frequent updates to remain relevant [12], [22], [23].

Regarding examination malpractice, [27] explored students' perspectives in Kenya and suggested strategies such as stricter supervision and policy enforcement. [28] examined the prevalence of malpractice among students in North-Central Nigeria and stressed the importance of both punitive and preventive measures.

[27] and [28] both highlighted that preventive and punitive measures are important for effective control of examination malpractice. But then, it is important that the disciplinary committee is objective in the administration of the recommended stringent deterrent policies or punitive measures since some of the erring students are aided by the supervisors as suggested by the study.

Despite these efforts, human biases often undermine punitive consistency. Expert systems, free from such biases, can provide equitable solutions. For instance, AI-based expert systems are effectively employed without bias in online and distance learning programs that aim to disseminate learning and knowledge-based activities to a wide audience [29], [30], [31], [32]. Expert systems have been used for intelligent tutoring systems, human tutoring and answer based tutoring purposes [53], [54], [55]. Their use in education has grown from just microcomputer-based to web and agent-based systems [34]. Applications like the Adaptive Educational Programme Tool (ADEPT) further demonstrate how expert

systems can enhance learning experiences [33].

Other areas where expert system has been applied include medicine and healthcare [35], [36], [37], finance [38], [39], manufacturing [40], [41], agriculture [42], [43], legal systems [44], [45], energy management [46], [47], transportation [48], [49], [50], and environmental management [51], [52].

Expert systems are not without their limitations. A significant limitation of using expert systems is that they are unable to generate innovative solutions and are affected by mistakes in the knowledge sources. They are expensive to maintain and need experienced experts to assess problems and offer solutions. Despite the limitations of expert systems, they offer valuable potential for applications like penalty allocation in academic settings. They promote fairness, reduce bias and support data-driven decision-making. This study explores their application in apportioning penalties for examination malpractice, an area with limited existing literature but significant potential for impact.

3.0 Methodology

The development of an expert system requires a concise implementation of some steps. Some of the main steps to be followed include: knowledge acquisition, representation, system design, rule-based implementation, database structuring, algorithm specification, testing and maintenance.

Expert systems basically feed on data or knowledge. Hence, in the development of this expert system, knowledge was primarily acquired from the Academic Board of

Federal Cooperative College, Ibadan (FCCIb) through interviews, focus groups, surveys, and institutional documents. This data was used to reflect institutional policies and expectations in the design of a decision tree algorithm.

Only when the expert's knowledge is presented in a way that consumers can comprehend and in a format that is comparable to what a human expert would typically do to solve the problem will a successful system satisfy the needs of the user [34]. The acquired expert knowledge was represented in the form of decision criteria and a rule-based decision tree. As shown in Figure 2, the decision tree is structured as series of branches, each representing a different decision criterion.

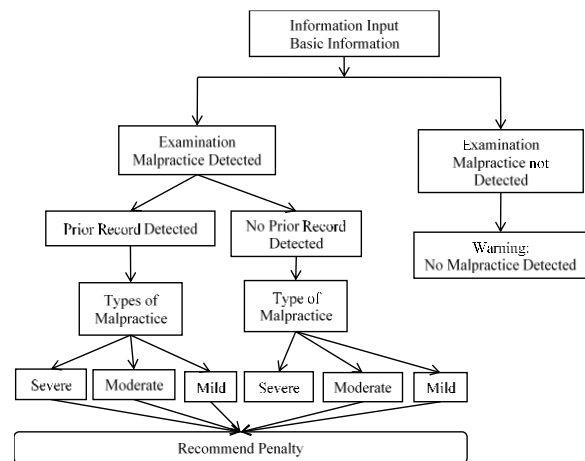


Figure 2: Malpractice Decision Tree

These criteria, such as malpractice type, severity and prior student records were weighted according to significance. The tree structure enabled stepwise decisions based on these attributes, thereby, mirroring real disciplinary committee reasoning. Based on input data (malpractice type, severity, prior record), the system generates a recommended penalty. The recommendation

considers institutional rules and is reviewed by the Academic Board before final implementation.

As shown in Figure 3, the knowledge base and database store all rules, criteria and student information. The knowledge base enables the system to match incidents with appropriate penalties efficiently. This facilitates consistency in disciplinary outcomes and supports clear communication with stakeholders.

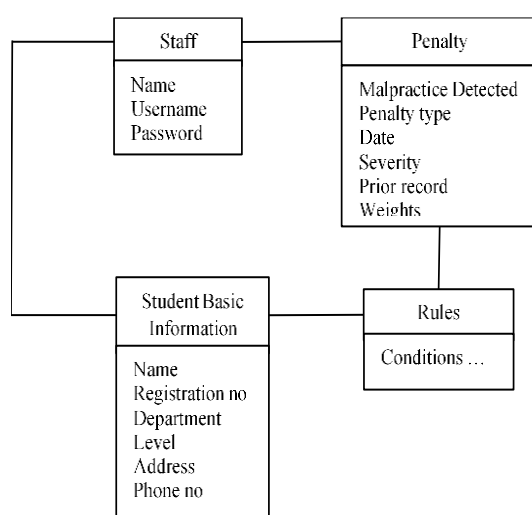


Figure 3: Database Design

An expert development tool, ES-Builder 3.0 was used to develop the system. The tool uses PHP and MySQL as the fundamental building tools, thereby providing a web-based ES Shell (ESS) that makes decision based on decision tree. The platform supports attribute configuration, rule encoding, and decision tree modelling. After initial development, the system was tested and refined using expert feedback to ensure correctness and usability.

Finally, acquired and properly represented knowledge is used to test the system and refine the decision tree and rules as needed.

This is aimed at identifying any problems or inconsistencies in the system before it is deployed. Iterative validation ensured that control mechanisms and inference procedures were accurate and aligned with expectations.

There is need to ensure a proper maintenance policy. This is to guarantee that the knowledge contained in the system is always up to date and in compliance with the evolving needs of the disciplinary committee and the organisation where the system is used. The system's maintenance includes periodic review and updating of rules and knowledge content. The task of performing maintenance procedures should be delegated beforehand and they should be formally documented.

4.0 Results and Discussion

The process of addressing cases of examination malpractice in most institutions is typically manual. This also is the case in FCCIb. Although the procedure at FCCIb follows a standardized approach, it remains labour-intensive. When a student is detected of engaging in examination malpractice, the student is required to fill a form providing necessary information. Afterward, the case is reviewed, a date is set for hearing to appear before the disciplinary panel. During the hearing, the student must defend themselves. If found guilty, they are referred to the student handbook, which outlines the types of examination misconduct and corresponding penalties. The panel then determines the appropriate penalty and communicates it to the student. This decision is documented in the College's records for future reference.

Processes like this may bring about challenges such as; risk of human error in data collection, interpretation and decision-making. It is often time-consuming, especially if multiple incidents occur simultaneously or if there are delays in gathering information or scheduling appearances and susceptibility to personal biases among panel members. These factors can lead to inconsistent or unfair outcomes. Moreover, as the number of cases increases, the manual process becomes harder to manage, compromising efficiency and effectiveness. These issues highlight the need for an AI-enabled expert system to support disciplinary decisions.

Using the College's student handbook as a benchmark, the performance of the expert system was assessed by comparing its penalty recommendations with those assigned by the disciplinary committee. This evaluation provides valuable insights into the system's ability to make appropriate penalty recommendations and contributes to ensuring fair and consistent treatment of malpractice cases. By focusing on the accuracy metric, we aim to find out whether the expert system can effectively support the maintenance of academic integrity within academic institutions.

A historical dataset comprising fourteen randomly selected examination malpractice cases from the Academic Board of FCCIb was used to compare the outcomes of the expert system with those of the disciplinary committee. Please note that these cases and the associated penalties are for illustration purposes only and not for any malicious intention.

Table 1 contains a summary of the misconducts extracted from the College's handbook and encoded into the system's knowledge base. Table 2 presents the outcomes of the fourteen historical cases. The same cases were fed into the expert system, and the penalties were compared against those assigned by the committee. Accuracy was calculated using equation (1).

$$\text{Accuracy} = (\text{No of Correct Predictions} / \text{Total No of Cases}) * 100\% \quad (1)$$

$$\text{Academic Board Accuracy} = 8/14 * 100\% = 71.43\%$$

$$\text{Expert System Accuracy} = 12/14 * 100\% = 85.71\%$$

The expert system correctly handled twelve of the fourteen cases. The two missed cases (CN), were those that were not represented in the system's knowledge base but were treated by the Academic Board regardless. This highlights a shortfall in the expert system. However, the expert system's overall 85.71% accuracy demonstrates its effectiveness in supporting academic integrity by aligning well with the handbook. The expert system's 85.71% accuracy rate over the Academic Board's 71.43% indicates that, the expert system has robust rule base, which ensures fair and consistent application of penalties. The rule base minimizes bias and enables context-specific recommendations by cross-referencing case details.

Table 1: Case Summary

Case No.	Offense/Misconduct Description	College's Handbook Penalty	Rationale
C1	Impersonation: Writing examination for another candidate	Expulsion of both with effect from the date offence was committed and culprit are not to be readmitted	Pre-mediated malpractice
C2	Falsification of examination marks or grades	Expulsion	Pre-mediated malpractice
C3	Hindering an invigilator or other examination officials while performing his/her legitimate duties	Suspension for one session	Interference with official duties
C4	Causing harm or damage on the invigilator or any examination officer	Expulsion	Violent interference on official duties
C5	Attempt to destroy or withhold evidence	Suspension for one academic semester	Deliberate action to obstruct the course of justice
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used	Suspension for one or two academic semesters	Pre-mediated malpractice/misconduct
C7	All forms of communication with another student candidate e.g. passing papers or dropping a paper which is then picked up by another candidate	Suspension for one semester	Unfair means to an end
C8	Copying from another candidate without actual transfer of answer paper	Cancel the exam paper of the collaborators if copying is confirmed by the examiners and culprits are to repeat the course	Use of unfair means to achieve result.
C9	Assisting another candidate to copy from his/her paper without actual transfer of answer paper	Cancel the exam paper of the collaborators if copying is confirmed by the examiners and culprits are to repeat the course	Aiding and abetting examination malpractice/misconduct
C10	Taking examination after having been barred from it because of non-attendance, serving a rustication, or other punishment	Cancel the paper, and candidate is to repeat the course	Seeking undue advantage
C11	Failure to stop writing at stipulated time	To lose 5% of examination attainable marks on the spot for the paper	Seeking undue advantage

C12	All case of examination/misconduct involving students who have completed their programme of studies (carryovers)	Expulsion	Pre-mediated malpractice/misconduct .
C13	A student who knowingly re-sits a paper he/she has already passed in a previous examination	Cancellation of the previous and current scores obtained in the paper	Pre-mediated malpractice/misconduct
C14	Failure to register for courses	Student will not be allowed to write the examination	Flouting a fundamental examination regulation
C15	Use of GSM (handset)	Cancel the paper and candidate to repeat the course	Unfair means to an end

Table 2: Expert System and Academic Board Penalties Assigned

Case No.	Expert System Penalty	Academic Board Penalty
C15	Use of GSM (handset): Cancel the paper and candidate to repeat the course	Use of GSM for an unfair means to an end. Paper should be cancelled and candidate to repeat the course
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board found you guilty of prepared material on previous question paper containing information related to the course being examined. Suspended for a period of one semester
C1	Impersonation: Writing examination for another candidate: Expulsion of both with effect from the date offence was committed and culprit are not to be readmitted	The Board found you guilty of stolen identity which is a pre-meditated offence. Consequently, you have been suspended for a period of one semester
CN	No knowledge	Caught with some information written on your palm, though not relevant to the course being examined. In line with the student handbook section 15.2 No 10 Discipline during examination, which you break. Therefore, you are hereby given warning letter to desist from such action which is against the school rules and regulations of the examination
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board found you guilty of being caught red handed with microchips in the examination hall. The microchip is relevant to the examination being examined. Consequently, you have been suspended for a period of one semester
C7	All forms of communication with another student candidate e.g. passing papers or dropping a paper which is then picked up	Caught in possession of microchip, which further investigation showed that information found in it were not of your handwriting but

Case No.	Expert System Penalty	Academic Board Penalty
	by another candidate: Suspension for one semester	of a fellow colleague. You are hereby given warning letter to desist from which is against the school rules and regulations of the examination
C3	Hindering an invigilator or other examination officials while performing his/her legitimate duties: Suspension for one semester	You were caught from your unruly behavior as a result of misunderstanding of language and your confession during the interview before the panel. Therefore, you are hereby given warning letter to desist from such action which is against the school rules and regulations of the examination
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board found you guilty of being caught red handed with plastic microchips in the examination. The microchip is relevant to the examination being examined. Consequently, you have been suspended for a period of one semester
C7	All forms of communication with another student candidate e.g. passing papers or dropping a paper which is the picked up by another candidate: Suspension for one semester	The Board found you guilty of exchanging question paper while examination is going on with your friend. Consequently, you have been suspended for a period of one semester
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board found you guilty of being caught with Phone and microchips in the examination hall. Consequently, you have been suspended from the institution for one semester
C15	Use of GSM (handset): Cancel the paper and candidate to repeat the course	The Board found you guilty of being caught with Phone during the examination. Consequently, you have been suspended for a period of one semester
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board found you guilty of being caught unauthorized prepared note while examination is going on. Consequently, you have been suspended for a period of one semester
C6	Bringing into the examination room, unauthorized prepared notes, drawings, tracings or books relevant to the examination being taken whether or not unauthorized materials are actually used: Suspension for one or two academic semester	The Board carefully considered your case including picture of your lap. Consequently, you have been suspended for a period of one semester

Case No.	Expert System Penalty	Academic Board Penalty
CN	No knowledge	you were caught with some information written on your palm, though not relevant to the course being examined as attested by the invigilator and your confession during the interview before the panel. Therefore, you are hereby given warning letter to desist from such action which is against the school rules and regulations of the examination

A high accuracy rate in penalty apportioning contributes significantly to maintaining academic integrity within the institution. By providing fair and consistent penalties for malpractice cases, the system helps to uphold academic standards and deters potential offenders. This, in turn, fosters a culture of honesty and ethical behaviour among students, faculty and administrators.

Despite its performance, ongoing feedback and periodic refinement of the expert system are essential. Regular reviews of user experiences and updates to the rule base will sustain accuracy and effectiveness.

5.0 Conclusion

Examination malpractice continues to pose a major challenge to academic institutions globally, necessitating the development of effective strategies to address such incidents. This study identified critical shortcomings in the traditional disciplinary process through interviews, document reviews, and a comprehensive literature analysis.

In response to these challenges, an expert system was developed to support penalty apportioning in cases of examination malpractice. The research focused on designing and implementing the system using ES-Builder 3.0, with PHP and MySQL as foundational technologies. The expert system features a comprehensive rule base and a user-friendly interface, ensuring ease of use for disciplinary committees. It was successfully tested with real-world data from the Federal Cooperative College, Ibadan (FCCIb), demonstrating its efficacy and providing a viable model for adoption by other academic institutions.

The evaluation of the system revealed a significant improvement in the accuracy of penalty apportioning, contributing to a more consistent, fair, and credible disciplinary process. These achievements lay a strong foundation for future enhancements and innovations in academic governance and disciplinary procedures.

While the expert system has made valuable contributions, there remains considerable opportunity for further research. Future work could explore the integration of machine learning techniques to enable adaptive learning from historical cases, thereby enhancing the system's intelligence and decision-making capabilities. Moreover, the ethical and legal implications of deploying an expert system for penalty apportioning; particularly concerning privacy, potential biases and alignment with institutional policies and regulations should be systematically investigated.

Declarations

Ethics approval and consent to participate

Not Applicable

Consent for publication

Not Applicable

Availability of data and materials

The datasets used in the study are available from the corresponding author on reasonable request.

Competing interests

The authors affirm that they have no conflicting interests.

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Authors' contributions

OO conceived the idea. In addition to designing and implementing the model, OO, OE, MJ and E carried out the research. The dataset was provided and verified by OE and E. OE shared practical expertise and made corrections to the manuscript. MJ structured the manuscript. All the authors contributed to the writing process and gave their approval to the final manuscript.

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