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Comparing structured note-taking and multiple-choice question writing as learning strategies among physiotherapy students

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Abstract

Background The education of health professionals plays a crucial role in developing the competence-based learning that is essential for their future practice. Increased student engagement and participation has been shown to significantly enhance academic achievement compared to passive knowledge integration during lectures or tutorials. However, the effectiveness of different learning strategies can vary depending on the individual and the context. This study investigated the impact of note-taking and generating multiple-choice questions (MCQs) on physiotherapy students' performance in summative examinations, as well as their preferences for using these methods.

Methods A cluster-randomised controlled crossover study was conducted among first-year undergraduate physiotherapy students enrolled in a psychology course at a Polish medical university. The study included 173 students (116 females, 57 males), aged 18–23 years. Following the psychology module, students completed a homework assignment, either a written note or an MCQ, which was subsequently reviewed by instructors. These materials were intended to support students' preparation for the final psychology examination. The effectiveness of each method as a tool for knowledge consolidation was evaluated using summative exam scores. Additionally, students provided qualitative feedback on their preferred learning method via an open-ended question.

Results There was no statistically significant difference at the 5% level in students' summative exam performance between the two learning methods. Overall, students expressed a preference for note-taking over the MCQ format, citing greater familiarity due to its use during their secondary education. However, students who began the learning process with the MCQ method demonstrated a slightly higher preference for that approach.

Conclusions Given the diversity of student preferences, the integration of note-taking and MCQ learning methods may optimise the educational experience in psychology training. Further research should investigate their equivalence, taking into account students' choice of learning method.

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Keywords Note-taking, Multiple-choice question, MCQ, Physiotherapy, Academic performance

Background

The education and training of health professionals is important in developing the competence-based learning necessary for their future professional practice. It has been shown that additional student engagement and participation can lead to better achievement of academic goals compared to their passive role in the integration of knowledge during lectures or tutorials [1].

Note-taking (NT) and multiple-choice questions (MCQs) are used in health educational settings [2]. Although the effectiveness of both learning strategies can vary depending on the individual and the context, some research suggests that both NT and composing MCQs can be effective in different ways [3–6].

NT can help students remember information, especially when they are encouraged to review and revise their notes [7]. Taking notes during and after class is a complex cognitive task that involves interrelated cognitive processes: attention, encoding, selection, organisation, elaboration (adding additional information to the note in order to fully understand the material) and reviewing. By developing these skills, students can improve their ability to learn and retain information from their classes [8, 9].

MCQs support teaching by facilitating test-enhanced learning, and they help learners identify knowledge gaps, enabling them to improve their study strategies. MCQs are time-efficient and easy to mark, providing more objective scoring than other methods. Designing effective MCQs for higher education requires careful consideration of content, format, structure and answer choice quality. An MCQ typically includes a problem statement (stem), one correct answer (key) and several incorrect but plausible options (distractors) [10]. Composing MCQs can also enhance learning by encouraging students to think more deeply about the material and to anticipate potential exam questions [11]. However, Fiorella and Mayer [12] found that students who generated questions during learning performed better on subsequent tests than those who simply took notes. This suggests that the active process of generating questions may lead to deeper processing and better understanding of the material. Moreover, creating MCQs also involves complex cognitive skills such as analysis, synthesis, and evaluation. It requires students to collect and synthesise information about the topic from multiple sources before generating each MCQ [4]. In this way, students can identify gaps in their knowledge and improve their higher-order thinking skills. While students might readily recognise the immediate advantages of answering MCQs, they may overlook the enduring cognitive benefits of formulating them. Hence, incorporating MCQ composition as a post-class activity can foster enhanced cognitive engagement and ultimately bolster their educational outcomes [6]. Nevertheless, student dissatisfaction with this format of education is common, partly due to its rigid structure and the disconnect from more interactive classroom experiences. At the same time, many instructors lack formal training in MCQ design, which can lead to poorly constructed items that compromise both assessment quality and student preparation [13, 14].

The available literature on learning strategies among Polish students has predominantly focused on those studying medicine. Studies have shown that self-directed techniques such as note-taking, highlighting, and annotating were the most frequently reported methods during the remote learning period of the COVID-19 pandemic [15]. The potential of MCQs as a learning strategy has also been explored among medical students over the past decade [16, 17]. In contrast, little is known about the learning approaches used by students in other health disciplines. This gap is striking given the central role of physiotherapists within interdisciplinary healthcare teams and the demands of their education, which requires mastering a broad body of knowledge while fostering critical thinking, synthesis, and inference [18]. To uphold high academic standards across health professions, it is important to provide diverse teaching methods tailored to students' preferences and needs, thereby supporting the achievement of their educational goals [18, 19].

Aim and research questions

To provide evidence on the effectiveness of different study methods, this research was undertaken to compare the effects of using NT and MCQ creation as homework assignments on final examination performance in a psychology course, and to present and discuss students' opinions on both methods. These two strategies were selected for investigation because they are among the widely used learning methods in health professionals education, are theoretically grounded in distinct cognitive processes (organisation and rehearsal in the case of note-taking, analysis and synthesis in the case of MCQ generation), and could be feasibly standardised as post-seminar assignments. Their established role in both student self-study and formal assessment also makes them particularly relevant for evaluating potential effects on exam performance. Other active strategies such as peer teaching or concept mapping were considered, but NT and MCQ generation were prioritised because of their direct alignment with assessment formats and the possibility of applying them consistently across all student

groups in a controlled trial. Based on the literature on the subject, the study considered the following research questions and hypothesis:

Research question 1

Is there a significant difference in first-year Polish physiotherapy students' summative examination performance between those who use NT and those who use MCQ creation in their homework assignments?

Research question 2

Which of the two methods is preferred by these students?

Hypothesis

We hypothesised that students who engaged in composing MCQs would achieve higher summative examination scores on items related to the seminar content than those who used NT, owing to the deeper cognitive engagement required for MCQ creation.

Methods

Participants

First-year students of physiotherapy from the Medical University of Lodz in Poland who took part in the psychology course were enrolled. The study group consisted of 173 participants (116 women and 57 men). Participants' ages ranged from 18 to 23 years (mean: 19.1 years; standard deviation: 0.69 years).

The study was conducted from October 2022 to February 2023.The research was conducted in accordance with the ethical principles set out in the Helsinki Declaration. The local Institutional Review Board gave an opinion that informed consent was not needed, in line with national regulations. Ethical approval for the study was gained from the Bioethical Committee of the Medical University of Lodz (RNN/218/22/KE).

During the first lecture, the objectives of the project were explained, and all students were briefly informed of procedures. Each person could ask questions to the instructors and had the opportunity to withdraw from the study at any time. Informed consent to participate in the study was obtained from all participants.

Setting and study design

To assess the impact of preparing notes and MCQs as post-seminar assignments on students' final test exam performance, a cluster-randomised controlled crossover study was conducted. All respondents participated in the psychology course taught by three academic teachers. The course consisted of 7 online lectures and six in person seminars. Data was only analysed from seminar material because this part of the course was obligatory. At the first lecture, a training session was held to familiarise students with the requirements for the post-seminar homework assignments. These consisted of either creating one MCQ or completing an NT submission. For NT, students were reminded that their task was to produce a 100–300 word structured summary of the seminar content, initiated during the seminar and refined afterwards. NT submissions were expected to capture the main concepts, demonstrate organisation of the material, include elaboration or examples to support understanding. Faculty provided examples of acceptable NT submissions and clarified expectations regarding length, focus, and clarity. For the MCQ task, students were instructed to demonstrate their understanding of the seminar content by formulating a single-best-answer (SBA) question. Each MCQ was required to include a clear stem, an explicit lead-in, one correct answer, and four plausible distractors, accompanied by a short explanation of the correct answer to demonstrate reasoning and alignment with seminar material. Faculty provided examples of acceptable MCQs and clarified expectations regarding structure, accuracy, and appropriate level of difficulty. The aim of the tasks was to reinforce and evaluate knowledge provided during classes as preparation for the final exam. MCQ assignments were reviewed by the course faculty. Each item was evaluated for accuracy, clarity, and relevance to the seminar content. All submissions (both NT and MSQ) were evaluated and graded on a pass/fail basis by the course faculty according to predefined criteria, ensuring consistency across groups.

The unit of randomisation was the DG. At the Medical University of Lodz, DGs are the standard administrative teaching subgroups, each comprising 8–15 students. In total, 14 DGs participated in the study. Randomisation was performed centrally using a computer-generated allocation sequence. DGs were stratified to ensure a balance in group size across arms before random assignment. Allocation concealment was maintained until after baseline instruction, when groups were informed of their assignment. Each DG was allocated to one of two study arms (Fig. 1). In Arm A, students created MCQ based on the topics covered in the first seminar, after which they wrote a note based on the second seminar. In Arm B, the sequence was reversed (note after the first seminar, MCQ after the second). This crossover ensured that all students completed both assignment types, while the initial allocation determined the order in which they engaged with each method. In DGs assigned to Arm A there were 91 participants, whereas in DGs assigned to Arm B there were 82.

For the exam, the teachers created nine questions (six MCQs and three short answer questions) for each of the topics taught. In total, 27 questions were created for the topics from seminar 1 of each teacher, which constituted one part of the exam (Test 1,T1). Similarly, Test 2 (T2), which tested knowledge of the topics discussed in

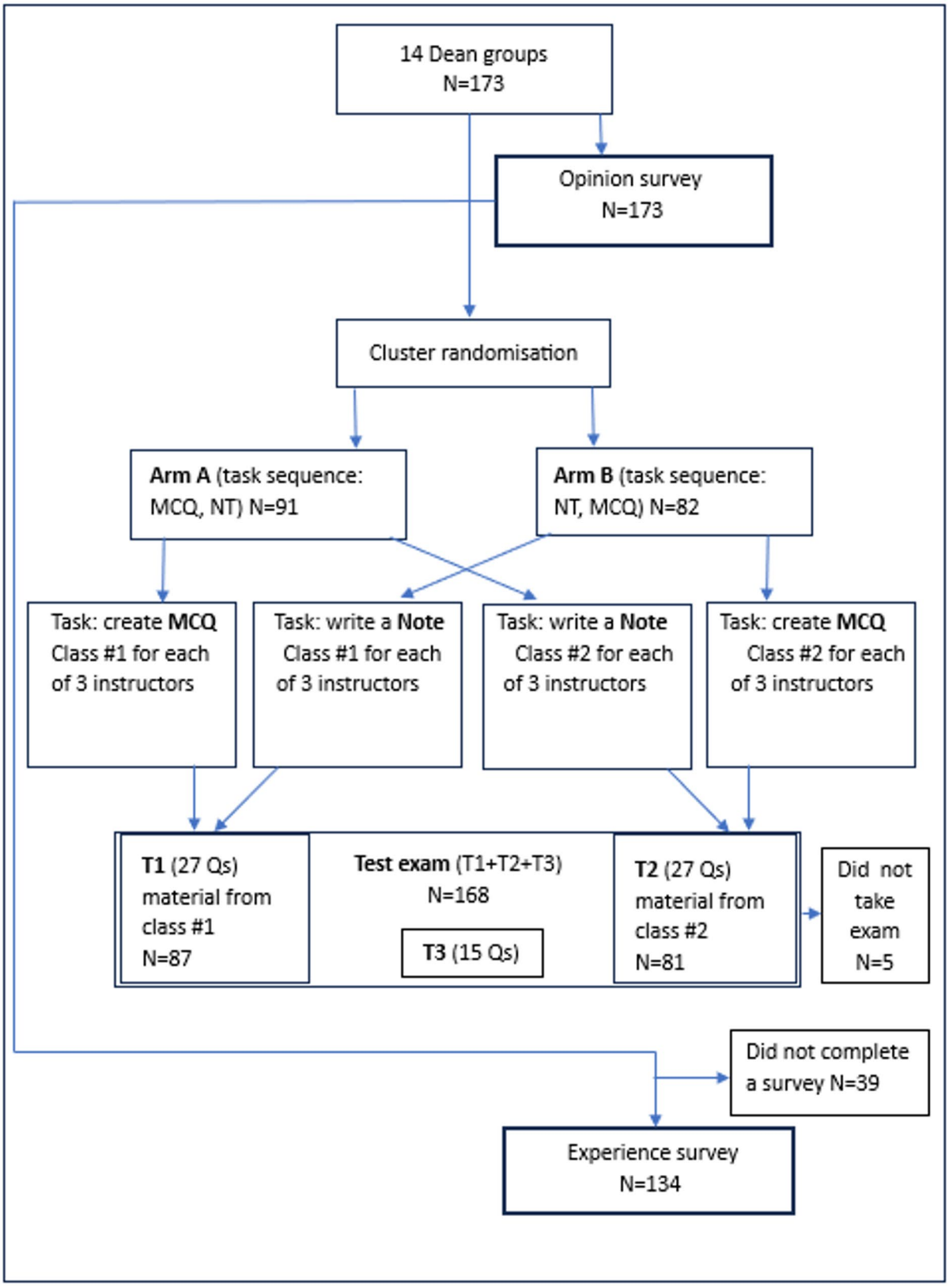

Fig. 1 Schematic illustration of the cluster-randomised controlled crossover study of NT vs. MCQ creation in physiotherapy students

seminar 2 of each teacher, consisted of 27 questions. The final exam therefore comprised 69 questions in total: 27 from T1, 27 from, and 15 questions relating to lecture topics (T3). To assess the impact of NT and MCQ assignments on performance, only results from T1 ($N = 87$) and T2 ($N = 81$) were included in the analysis.

Students' attitudes towards learning methods were collecting by using an on-line survey after the final exam. A total of 134 students (77.5%) responded. Students were asked: "Being able to choose only one of these two methods to support learning, which of the methods would you choose: NT or MCQs?" and students were then asked to justify their choice. All responses were independently reviewed by two judges (KWBO and JR). Themes and categories were identified, a uniform coding frame was agreed upon through discussion, and a second round of independent categorisation was performed. Any discrepancies in coding were resolved by consensus.

Data analysis

The statistical analyses were performed using Statistica v. 13 (TIBCO Software Inc.). To determine the required sample size for this cluster-randomised controlled trial, an initial power analysis was executed via G*Power. Assuming an effect size d = 0.3, the software's estimation yielded a sample size of 90 under the premise of individual randomisation, set at $\alpha = 0.05$ and $\beta = 0.8$. Acknowledging the clustered structure of our research design, adjustments were necessary to accommodate for intracluster correlation. As such, the final adjusted sample size deemed necessary for the study was established.

To compare student performance, the significance of T1 and T2 scores between the study arms was determined using the Mann-Whitney U test ($N = 168$). The third part of the final exam (T3) assessed knowledge of lecture content. Unlike the seminar topics (T1 and T2), the lecture material was not linked to the randomised intervention, as students were not assigned to prepare either notes or MCQs for these sessions. To preserve the internal validity of the study and ensure that only outcomes directly attributable to the randomised intervention were analysed, T3 results were excluded from the comparative analysis.

To ensure a consistent and comparative evaluation of the examination data, results from the two sections of the examination test (T1 and T2) were standardized using Z-scores. Comparisons of standardized T1 and T2 scores within the same study arm were assessed using the Wilcoxon signed-rank test, with matched-pairs rank-biserial correlations and 95% confidence intervals reported to indicate the magnitude of within-group differences. Additionally, to compare the frequency of the revision method preferences in the post-survey, the chi-square test was employed.

Results

The effect of NT and MCQ creation on student exam performance

Of the 173 students initially enrolled, 168 (116 women, 52 men) completed the final exam, yielding a completion rate of 97.1%. In the intra-group analysis for Arm A, contrasting T1 with T2 revealed no statistically significant differences ($p = 0.142$; $r = 0.149$, 95% CI [−0.057, 0.356]). Similarly, for Arm B's intra-group evaluation, the differences between the tests were not statistically significant ($p = 0.111$; $r = -0.136$, 95% CI [−0.358, 0.086]). In the inter-group assessment of T1, distinguishing between Arm A and Arm B, there were no significant differences detected ($p = 0.161$; $r = 0.125$, 95% CI [−0.052, 0.299]). Likewise, the inter-group analysis for T2 also demonstrated no significant variance between the two arms ($p = 0.296$; $r = -0.094$, 95% CI [−0.263, 0.079]) (Table 1).

Student perceptions of NT vs. MCQ creation

Of the 168 students who completed the course, 134 (77.5%) students completed the post-course survey, providing both quantitative preferences and qualitative justifications. Quantitatively, significantly more students preferred NT when being able to choose only one between NT or MCQ to support learning ($N = 116$, 86.6% vs. $N = 18$, 13.4%; z = 8.379; $p < 0.001$).

However, those who prepared MCQ as their first post-classes task (Arm A) were more likely to appreciate this

Table 1 Standardised scores of both parts of the exam test (T1 and T2) in both arms of the study ($N = 168$). Inter-group comparisons: Mann-Whitney U; intra-group comparisons: Wilcoxon T

Arm	T1				T2			
	Me	IQR	Min	Max	Me	IQR	Min	Max
A ($N = 87$)	−0.07[1A]	1.15	−2.76	2.23	−0.11[2A]	1.31	−2.07	2.83
B ($N = 81$)	0.31[1B]	1.15	−2.38	3.00	−0.11[2B]	1.31	−2.40	1.85
Total	−0.07	1.15	−2.76	3.00	−0.11	1.47	−2.40	2.83

[1A/2A] T = 1567.00; $p = 0.142$

[1B/2B] T = 1322.00; $p = 0.111$

[1A/1B] U = 3081.50; $p = 0.161$

[2A/2B] U = 3193.50; $p = 0.296$

Table 2 Themes for choosing NT vs. MCQ creation with number of exemplar quotes

The reason for preference	Students' quotes
Opinions on MCQ	
Interesting & creative form of learning	*"Composing questions was more enjoyable for me because I could be creative and get into the role of a therapist"*
	"Is more interesting and less monotonous than taking classic class notes"
Effectiveness of the method	*"This is an innovative and, in my opinion, more effective method of learning [than NT], because it stimulates our creativity, we can imagine life situations that fit the issue, and based on this we can make conclusions and remember the issue in the long run."*
	"Creating questions was a better way for me to repeat the material after class"
	"They make me think typically in terms of the exam"
	"A question is created shorter (than NT) and contains condensed knowledge on a given topic"
Opinions on NT	
Effectiveness of the method	*"The notes force us to create such a "mental shortcut" on the issues, which not only can be used for learning, but the very reading of such content makes us often able to add the rest on our own, which we associate from the class or from another source."*
	"For me, creating notes is a longer [than MCQ], but consequently a more effective way of learning."
	"More knowledge in less effort."
	"[notes] seem to me to activate the student's attention and memory more."
	"By NTs, I remember more and repeat the material more. NT is useful for further study for an exam."
Student-friendly method	*"I have been choosing this form for many years and perhaps it is a matter of habit and convenience."*
	"I learn more easily when I can use my own form of language and not come up with false answers (distractions) that I could accidentally remember."
	"Can be easily shared with others"

method than students from Arm B (19% vs. 7%; $\chi^2 = 4.28$; $p = 0.039$; phi = 0.19).

The qualitative analysis revealed two categories in relation to NT: effectiveness of the method and student-friendly method. The process of NT was described as activating attention and memory, making it a preferred method for long-term study. The predominant rationale for selecting NT was the students' belief that this is a more effective form of learning that covers a broader range of knowledge and allows for better assimilation, comprehension and repetition of information in less time than MCQ preparation. Another argument in favour of NT was its evaluation as a student-friendly method; students admitted that they prefer notes because it is a known method, easier to do and implement in learning, and less tiring than creating an MCQ. Students appreciated being able to use their own language and avoid memorizing incorrect answers.

Two categories were noted for analysis of MSG preferences: interesting and creative form of learning and effectiveness of the method. Those who chose MCQs as their preferred method of learning argued that it was more interesting, less monotonous, and more creativity-inducing than the NT. Respondents appreciated the concise format of the MSGs, which emphasised key concepts and allowed them to visualise themselves in professional situations and roles. Students pointed out other advantages of the MCQs - that they are more effective than notes in terms of exam preparation. Participants highlighted the efficiency of repetitive memory stimulation that reinforces knowledge on a specific topic, noting its advantage in time-saving when compared to the process of NT (Table 2).

Discussion

Transitioning into the nuanced cognitive strategies in writing, it becomes clear that NT predominantly aligns as a "knowledge telling" strategy. In contrast, composing MCQs, especially those accompanied by clinical vignettes or real-life scenarios, tends to activate the more intricate "knowledge transforming" strategy [20]. This study found no significant difference in students' of physiotherapy exam performance whether notes or MCQ creation was used as a summarising of knowledge obtained during seminars. From the perspective of cognitive learning theories, this absence of significant quantitative differences may be interpreted in several ways. According to the levels of processing framework, NT predominantly supports shallow-to-intermediate processing by emphasising selection, organisation, and rehearsal of information, while MCQ creation requires deeper generative processing such as analysis, synthesis, and evaluation [7, 10]. Both strategies therefore engage important but distinct cognitive pathways, which may help explain why neither method produced a clear advantage in exam performance in our study. From the perspective of cognitive load theory, creating MCQs may impose a higher intrinsic and extraneous load on novice learners, particularly first-year students with limited prior exposure to this activity. This may have offset the potential benefits of deeper engagement. Conversely, NT, although more familiar and less demanding, may have encouraged rehearsal and organisation without necessarily stimulating higher-order knowledge transformation. In line with generative learning theory, both tasks can be seen as active strategies that prompt learners to produce rather than merely receive information; however, the effectiveness of these strategies likely depends on prior familiarity and on the scaffolding provided.

The qualitative data showed students generally preferred NT over question creation as a learning method. However, those who began by creating MCQs showed

a higher preference for this method and for many this was the first time they had ever created MCQs. Indeed, the "exposure effect" demonstrates that people tend to develop a preference for things merely because they are familiar with them [21]. Therefore, we assume that those who started with creating MCQs might have developed a slightly greater preference for this method due to their greater initial familiarity with it.

Interpreting our findings within Kirkpatrick's evaluation framework, this study primarily addressed Level 1 (students' reactions and preferences) and Level 2 (learning outcomes as reflected in examination performance) [22]. No significant differences were observed at the learning level, although as discussed above, differences emerged in student preferences. Higher levels of the framework, including behaviour and long-term outcomes, were beyond the scope of this trial but remain important areas for future investigation.

The literature also suggests that students' attitudes towards composing MCQs as a learning task are mixed. Our research is one more in which students, despite creating valid questions, underestimated their educational value [23]. Students often express a dislike for composing MCQs as a learning task. This can be attributed to several factors. Firstly, creating MCQs requires a higher cognitive load than simply answering them. Students must not only understand the material but also apply it in a way that creates a valid question and plausible distractors [24]. This can be challenging and time-consuming, leading to frustration. Students may feel that the task does not contribute to their learning. Further, they may perceive the creation of MCQs as a teacher's responsibility, not a learning activity [25]. Therefore education of the benefits of MCQ creation must be explained to the students before integrating this method into curricula.

On the other hand, research suggests that students have positive attitudes towards composing MCQs, which they see as an effective learning strategy that promotes higher-order thinking and deep learning. It encourages students to think critically about the material, understand it deeply, and apply it in a new context [26]. Furthermore, students appreciate the opportunity to actively engage with the material and take ownership of their learning. However, it is important to note that the effectiveness and enjoyment of this method can vary depending on the individual student's learning style, the subject matter, and the way the task is implemented [3]. It seems that, in the case of our study, the obligatory nature of the task and the specificity of the subject could have resulted in a reluctant attitude of students towards composing MCQs. Perhaps giving individuals the possibility to choose their preferred method of learning in the future could potentially improve exam performance and this personalised preference approach should be considered in future studies. A notable strength of our study is that it fills a knowledge gap concerning learning support methods amongst the Polish physiotherapy student. However, it is important to note that our study design allows for a comparison between NT and MCQ creation but does not directly evaluate the independent effectiveness of each method on examination results. While numerous studies have emphasised the efficacy of both tools in aiding learning [6, 27, 28] our research design does not provide a direct demonstration of this efficacy in this narrow head-to-head setting. The results seen in this study here may be related to the subject matter of the seminars (non-clinical content). The seminar topics included complex content related to understanding the patient-medical practitioner relationship, which can be quite challenging for first-year students.

An additional consideration for future research and educational practice is the impact of generative artificial intelligence (AI) on learning tasks. The growing availability of tools capable of rapidly producing essays, summaries, or MCQs raises questions about the continued viability of take-home assignments as authentic measures of student effort. Although AI solutions show promise in generating MCQs, particularly for educational purposes, the validity of AI-generated content, especially in medical education, remains under-researched and is highly dependent on the quality of the prompt. Despite the mixed results and the need for expert oversight, AI tools remain still a valuable and time-saving resource for developing MCQs [29].

While AI can affect both NT and MCQ creation, it is particularly relevant to tasks completed outside of class without supervision. This underscores the need for educators to critically appraise how generative AI may alter students' engagement with these strategies. In the short term, institutions may rely on AI-detection software to identify unauthorised use, though such tools remain imperfect and should not replace thoughtful task design. One potential solution is to integrate these activities into in-class or supervised settings, where students can still benefit from the cognitive processes of generation and elaboration while maintaining accountability. Another promising direction may be to use student-generated MCQs not only as a learning task but also as part of peer-testing or formative assessments, ensuring accountability, authenticity and pedagogical value. Ultimately, fostering students' ability to critically evaluate the outputs of AI tools is likely to become a core competency of health professional education in the years ahead.

Limitations

Several limitations of this study should be acknowledged. First, while the cluster-randomised crossover design reduced some sources of bias, the study was conducted

within a single institution and on a single course, which may limit generalisability of the findings to other disciplines, universities, or cultural contexts. Second, the sample consisted exclusively of first-year physiotherapy students. Their relative inexperience with higher education and with self-directed learning strategies may have influenced both their performance and their preferences, particularly in relation to MCQ creation, which was unfamiliar to many. Third, although the crossover design is a strength, the study was not powered to detect very small differences between note-taking and MCQ creation, and the use of cluster randomisation by discussion group introduced potential intra-cluster correlation. This may have reduced the effective sample size and statistical power to detect differences at the 5% level. Fourth, although we collected valuable qualitative data, the survey relied on self-report and voluntary participation (77.5% response rate). It is possible that non-respondents differed systematically from respondents in their learning preferences or experiences, which could have biased the findings. Finally, as the intervention was embedded in a compulsory course, students may have been motivated more by the need to fulfil requirements than by genuine engagement with the learning strategies. This obligatory nature could have influenced both their performance and their attitudes. Future research should consider multi-site trials, larger sample sizes, inclusion of different health professions, and alternative designs that allow for evaluation of long-term retention and transfer of knowledge.

Conclusion

Educators should consider offering both NT and MCQ creation to students, thereby catering to diverse learning preferences and enhancing the overall educational experience. Allowing students to choose their preferred learning method may positively influence their engagement and subsequent examination performance and this approach should be examined in future studies. In addition, the implementation of a student-centred teaching model could be effective in learning and retaining knowledge and developing competencies as health professionals [30, 31].

Abbreviations

DGs	Dean groups
MCQs	Multiple-choice questions
NT	Note-taking
T1	Test 1
T2	Test 2

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Authors' contributions

MW: Methodology, Investigation, Writing – Original Draft. JR: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft. KWBO: Methodology, Investigation, Writing – Original Draft. MK: Methodology, Investigation, Writing – Original Draft. VA: Writing – Original Draft. SRLH: Methodology. JLW: Writing – Original Draft. AH: Writing – Original Draft. BHLH: Conceptualization, Methodology, Formal analysis, Writing – Original Draft. All authors reviewed the manuscript.

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Data availability

The anonymized dataset generated and analysed during the current study is available in the Zenodo repository, DOI: 10.5281/zenodo.15861339.

Declarations

Ethics approval and consent to participate

The research was conducted in accordance with the ethical principles set out in the Helsinki Declaration. The local Institutional Review Board (the Bioethical Committee of the Medical University of Lodz) gave an opinion that consent was not needed, in line with national regulations (RNN/218/22/KE).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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