
ORIGINAL ARTICLES

Development of a mobile marking system for a multiple-choice examination to improve educational effects

SUGIYAMA AKIKO, TAKIGAWA TOSHIYA

Answer mark cards for multiple-choice examinations are usually marked by an optical mark reader in an administrative room. The data are compiled, and a list of scores is displayed to students on a bulletin board. In this conventional marking method, there is a time gap between when the test is taken and when students receive their scores; memories of the examination may have faded by the time the scores are received, and students have difficulty understanding their mistakes or progress. Providing examination results more quickly would allow teachers to adjust their course content based on student achievement, and it would increase motivation among students, who would be better able to understand their learning progress in terms of both absolute and relative evaluations, namely, score and rank. We developed a novel mobile marking system that could quickly mark examinations and immediately provide visualized results, improving the educational efficacy of examinations. This system was first introduced during oral anatomy practical examinations among sophomore students at Asahi University School of Dentistry in 2019. The examinations were scored immediately, and the results were given to the students. Then, an explanatory lecture was performed to provide feedback on the results. When all lectures were complete, questionnaires were distributed to the students to ascertain the educational effects of the system. It was found that students' motivation to learn increased when they learned their marks and ranks immediately from the mobile scoring system. Thus, it was found that educational effects could increase through increasing student motivation by means of the mobile marking system.

Key words : Mobile marking system, Absolute evaluation, Relative evaluation, Feedback, Motivation to learn
Abbreviation : Ans., Answer

Introduction

Examinations are important component part of education; both students and instructors can use the results of examinations to assess learning and plan for growth. Students who observe their examination results and understand their level may change their thinking and attitudes toward learning in response. Students who are aware of their own lack of knowledge on a subject may work harder as a result. Instructors can also better analyze their students' results to pinpoint successes and failures and adapt their teaching in relation to their students' needs.

Our study focused on the practical examinations that take place during an oral anatomy course

at Asahi University School of Dentistry. The students take a multiple-choice examination at the beginning of class, and an explanatory lecture is given immediately following the examination on the examination questions to enhance the students' understanding of the concepts being tested. To make the examination most effective, both instructors and students should have rapid access to the results, not only in absolute but also in relative terms, including individual score and rank, average score, correct answer rate, and discrimination index, as soon as possible to have receive relevant feedback and adjust in response. To improve this, a mobile marking system was developed that can provide examination results within five minutes^{1, 2)}; this system can both

Department of Oral Anatomy, Division of Oral Structure, Function, and Development, Asahi University School of Dentistry

1851-1 Hozumi, Mizuho, Gifu, 501-0296, Japan
(Accepted November 5, 2020)

mark examinations and provide feedback. The mobile marking system was used in the oral anatomy class, and its educational effect was verified.

Materials and Methods

Materials

The optical mark reader (OMR) SR-430 plus and SSkun Super software, were purchased from Educational Software Co., Ltd. (Tokyo, Japan). The printer was purchased from Canon (Tokyo, Japan). The computer was purchased from HP Japan Inc. (Tokyo, Japan). The software to visualize the examination results had previously been developed^{1,2)}.

Methods

Practical examinations were performed once a week in the oral anatomy class. Sophomore students at Asahi University School of Dentistry answered multiple-choice questions and gave their answers on mark cards that were immediately marked in the lecture room by the mobile marking system. Visualization of the examination results were printed on paper and projected onto a screen using a document camera. The results shown to the students gave the score and rank of each student, the overall average score, correct answers, correct answer rates, and histograms of the scores. In addition to this, the instructors were also shown the discrimination index. Then, an explanatory lecture on the examination questions was conducted to provide feedback. When all lectures for the given term had been delivered, anonymous questionnaires on the mobile scoring system were administered to the students, who were informed that they could choose whether they wished to complete the questionnaire and that there would be no penalty for non-completion. They were also informed that the results of the questionnaires might be published at an academic meeting or in a published paper. The same information was given orally before the questionnaires were disseminated. The submission of the questionnaire was considered to indicate consent.

Results

The mobile scoring system is situated in a rack with casters, both in (Fig. 1B) and out of (Fig. 1A) use. The examination results processed by

the mobile scoring system were projected onto a screen (Fig. 2). A questionnaire on post-examination lectures using the mobile marking system was given to the students. It was shown that 67.1% of 137 students wanted to know their scores as soon as possible (Fig. 3); 76.6% of 137 students said that it was helpful to know the scores or ranks immediately

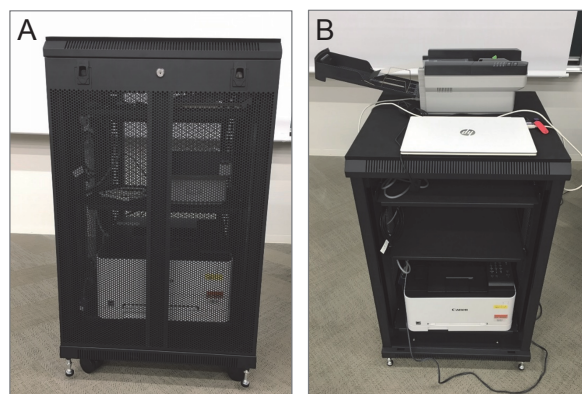


Fig. 1. Mobile scoring system, not in use (A) and in use (B). This system includes an OMR, a computer, and a printer.

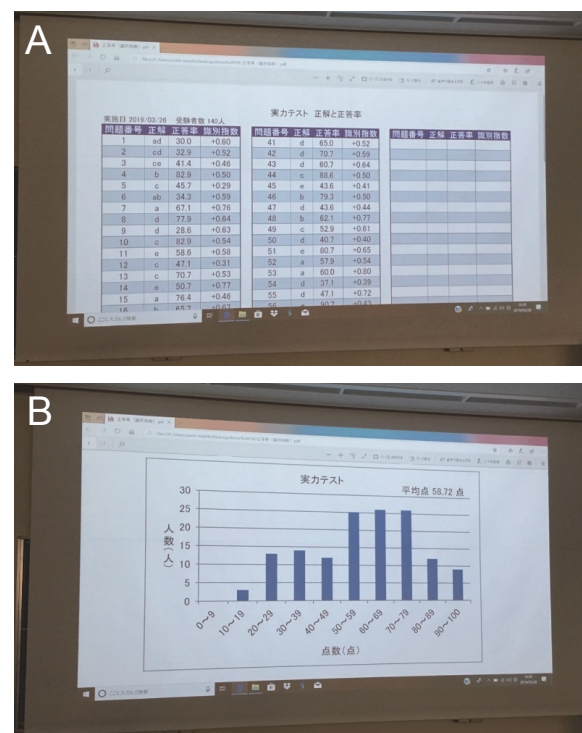


Fig. 2. Processing of examination results by the mobile scoring system, with a table of correct answers and correct answer rates (A), histograms of score levels, number of students, and average scores (B).

after an examination (Fig. 4). Moreover, 59.4% of 133 students indicated that there was a difference between learning their examination results and not knowing them while listening to an explanatory lecture on the examination (Fig. 5). A difference was

A mobile marking system to improve educational effects

found in their attitudes: 57.1% of 98 students said that they listened to the explanatory lecture more attentively when they knew their scores and ranks, and 82.7% said that their motivation increased when they were conscious of their score or rank (Fig. 6).

Question 1.

What do you think of the immediate marking of mark cards of an examination in the lecture room?

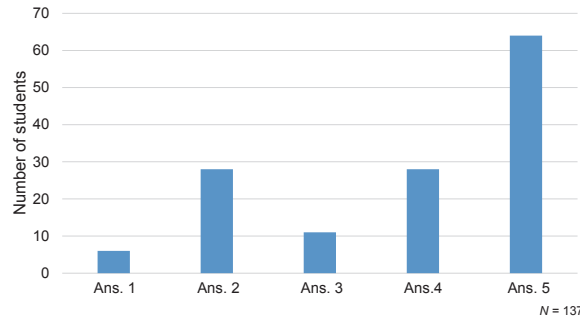


Fig. 3. Responses to question 1.

Ans. 1, I do not want to know my mark; Ans. 2, There is no need to know my mark immediately; Ans. 3, I want the mark on the bulletin board by the end of the school day; Ans. 4, I want to know only my mark as soon as possible; Ans. 5, I want to know my mark and rank order as soon as possible.

Question 2.

What do you think of knowing your mark and rank immediately after the examination?

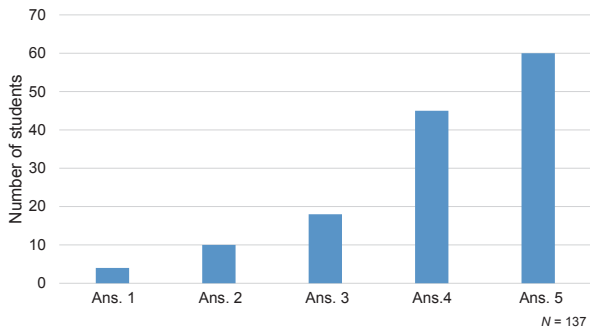


Fig. 4. Responses to question 2.

Ans. 1, It is not helpful at all; Ans. 2, It is slightly helpful; Ans. 3, I cannot decide; Ans. 4, It is partly helpful; Ans. 5, It is very helpful.

Question 3.

Is there a difference between knowing and not knowing your examination mark as you listen to an explanatory lecture after an examination?

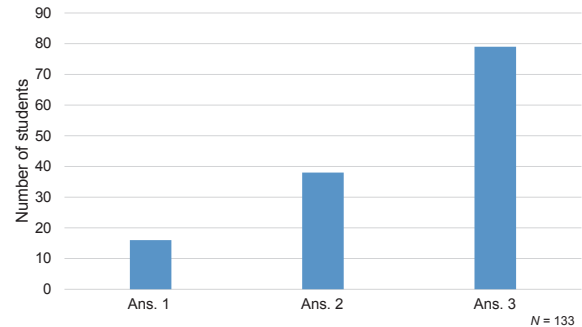


Fig. 5. Responses to question 3.

Ans. 1, No; Ans. 2, I cannot decide; Ans. 3, Yes.

Question 4.

For those who answered "Yes" to question 3: What is the difference in listening to the lecture while knowing your examination results? Please choose from these options. You can choose more than one.

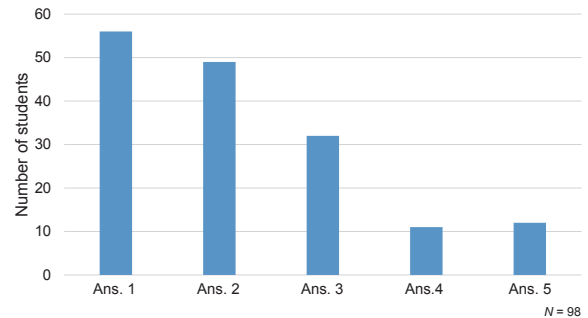


Fig. 6. Responses to question 4.

Ans. 1, I can carefully hear a lecture about my wrong answers when I am conscious of my mark and rank; Ans. 2, My motivation to learn increases when I know my mark; Ans. 3, My motivation to learn increases when I know my rank; Ans. 4, My motivation to learn decreases when I feel low because of my low mark; Ans. 5, My motivation to learn decreases when I feel low because of my low rank.

Discussion

A guarantee of quality in higher education is important³⁾. Institutions of higher education are obligated to educate students in specialized knowledge and skills. Medical and dental students must pass computer-based testing administered by the Common Achievement Tests Organization to certify that they have the necessary standard general knowledge before they begin clinical training⁴⁾. Graduates of medical and dental universities become medical and dental professionals qualified by their results on national examinations. Such universities are required to implement an education that measures up to international standards⁵⁾. Those universities must develop their students' abilities and educate them effectively and efficiently. Examinations constitute an effective educational method for improving learning^{6, 7)}. The results of our study suggest that a mobile marking system is useful for effective education. Teachers assess the understanding of their students based on examinations, and quickly receiving the scores helps teachers improve their teaching. Examination results could be enhanced where answer sheets are returned with information on whether answers are correct, accompanied by comments to the questions⁸⁾. This procedure enables students to consider their own responses. Many students answered that they wished to know their scores as soon as possible and that prompt examination results were helpful to their learning (Fig. 3, 4). Over half (57.1%) of the students answered that they paid closer attention to the lecture when they had already known their scores and ranks (Fig. 6), and 82.7% answered that their motivation was increased when they knew their scores or ranks (Fig. 6). Students' motivation to learn on their own is important for increasing the quality of their learning performance and their growth⁹⁾. Both their absolute evaluations, namely scores, and relative evaluations, namely ranks, increased their motivation to learn, in relation to their responses to questionnaires. Metacognition is an important way to understand one's own academic ability through relative evaluation and is an important skill for learning effectively^{10, 11)}. It is thought that relative evaluation promotes students'

metacognition of their real ability and motivates them¹²⁾. If students only knew their scores from a bulletin board after school, they might not listen attentively to post-examination lectures, and many students in our study indicated that they paid closer attention because they realized their examination results (Fig. 6). Moreover, students tend to forget examination contents, and their motivation to learn tends to decrease as time passes. Post-examination lectures should occur as soon as possible after an examination and should show examination results with both absolute and relative evaluations. This underscores the importance of marking examinations immediately in the lecture room. The educational effects of the examination will increase if prompt and appropriate feedback is supplied to the students through a mobile marking system.

Conclusion

1. We developed a mobile marking system that could mark multiple-choice examinations and provide visualized results to students immediately following an examination.
2. It was found that students' motivation to learn increased when they knew the examination results.
3. It was demonstrated that the educational effects of the examination increased due to the use of a mobile scoring system.

Acknowledgment

This study was supported by a grant aid for promotion of educational reform in Asahi University in 2018.

Conflict of interest

The authors declare no conflict of interest associated with this manuscript.

References

1. Sugiyama A, Ohashi T, Takigawa T. Development of a macro program to visualize the examination result data in Asahi University School of Dentistry. *J. Gifu Dent. Soc.* 2016; 43: 73-81.
2. Sugiyama A, Ohashi T, Takigawa T. Development of a macro program for creating learning portfolios for teaching and learning institutional research (IR). *J.*

- Gifu Dent. Soc. 2017; 44: 1-9.
3. National Institute for Academic Degrees and Quality Enhancement of Higher Education. Shitsuhosyou system no genjyo to syourazou ni kansuru kenkyuukai. Kyouiku no naibushitsuoshou ni kansuru guidelines. March 31, 2017. [Guidelines for internal quality assurance in education]. http://www.niad.ac.jp/n_shuppan/project/_icsFiles/afldfile/2017/06/08/guideline.pdf (Retrieved on December 17, 2020) (*in Japanese*)
4. Common Achievement Test Organization (CATO). <http://www.cato.umin.jp/> (Retrieved on December 17, 2020)
5. Japan Accreditation Council for Medical Education (JACME). <https://www.jacme.or.jp/> (Retrieved on December 17, 2020)
6. Bloom BS, Hastings JT, Madaus GF, Kajita E, Shibutani K, Fujita E, trs. Handbook on formative and summative evaluation of student learning. (Japanese-translated version) Tokyo: DAI-ICHI HOKI Co.,LTD.; 1987. 162-190.
7. Kajita E. Kyouiku ni okeru hyouka no riron. [Theory of the evaluation in the education] 11th ed. Tokyo: Kanekoshobo; 1984. 103-124. (*in Japanese*)
8. Hashimoto J. Gakusyuuhyouka no kenkyu —Koukateki na gakusyuuhyouka no kisoriron—. [Study of the learning evaluation. —Basic theory of the effective learning evaluation—] Tokyo: Toshobunka; 1974. 165-208. (*in Japanese*)
9. Kage M. Gakusyuuiyoku no riron—Doukiduke no kyouikusinrigaku—. [Theory of motivation to learn —Educational psychology of motivation—] Tokyo: Kanekoshobo; 2015. 2-33 (*in Japanese*)
10. Dunlosky J, Metcalfe J, Yukawa R, Kinjo H, Shimizu H, trs. Metacognition. (Japanese-translated version) Kyoto: Kitaohji Syobo; 2014. 192-219.
11. Sugiyama A, Ohashi T, Takigawa T. Chronological changes in examination scores for oral anatomy classes among second grade students in Asahi University School of Dentistry. J. Gifu Dent. Soc. 2016; 42: 71-79.
12. Sugiyama A, Takigawa T. Gakusyuuseika to soutaijyuni no kashika niyoru gakusei kokojin no jikoseisatsu to gakuseidoushi no sessatakuma no sokusin. [Promotion of individual self-examination and friendly rivalry of the students by visualization of examination results and relative ranks] Japan Universities Association for Computer Education. 2019endo ICT riyuu niyoru kyouikukaizenkenkyuuhappyoukai siryousyuu. 2019; 105-108. (*in Japanese*)

教育効果を向上させるための多肢選択式問題試験のための モバイル採点システムの開発

杉 山 明 子 滝 川 俊 也

多肢選択式問題試験の解答マークカードは通常、試験終了後に講義室ではなく事務課の光学式マーク読み取り装置で採点される。採点したデータは集計され、成績一覧表が掲示板で学生に開示される。このような従来の採点方法では、試験の実施から試験結果の開示までに時間を要し、学生は得点を知るまでに試験の記憶が薄れてしまい、自身の学修の誤りや向上を理解することは難しいと考えられる。迅速に試験結果を知ること、教員は講義内容を学生の習熟度に合わせることができ、また、学生は絶対評価である得点や相対評価である順位を知ることによって自身の学修の状態を理解することができ、学修意欲が増すと考えられる。そこで、試験の教育効果を向上させるために、迅速に採点を行い、試験結果を開示できるモバイル採点システムを開発した。2019 年度の朝日大学歯学部 2 学年の口腔解剖学の実習試験にモバイル採点システムを導入し、試験後、直ちに採点を行い、種々の試験結果を学生に開示した後、フィードバックのために試験の解説講義を行った。全ての講義終了後にその教育効果を検証するためにモバイル採点システムについてアンケート調査を行った。その結果、モバイル採点システムを使用した迅速な採点による試験結果の開示は、学生の学修意欲を向上させ、教育効果を上げることができると判明した。

キーワード：モバイル採点システム、絶対評価、相対評価、フィードバック、学修意欲