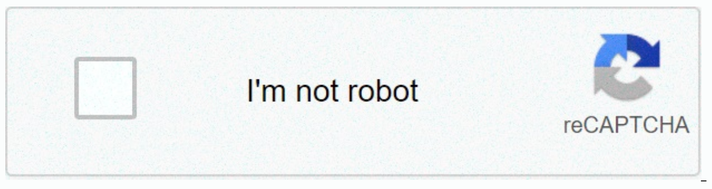

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Genetics probability problems and solutions pdf

1.3 Genotype and Phenotype 2. Mendel's first law segregation 2.1 2.2 sample 1 2.3 problem 1 2.4 Trial of Mendel 3. The joint inheritance of 5.1 characteristics, two inherited characteristics 5.2 genetic link 5.3 problem 4 6. 3. Problem 6 7. The staff were very friendly and helpful. Issue 8: Normal estimation with binomial counting standard height 8.3 and relative relationship 8.4 Problem 9: Some bits and pieces on continuous dsns 9. For example, humans have 46 chromosomes, each human receives twenty-three chromosomes from each parent. A pair of chromosomes have about one to twenty-two numbers, respectively, in a reduced size. These chromosomes are the last two chromosome autosomes, the last two x and Y sex chromosomes, each chromosome is different, and the automatic chromosome or given gender often has the same information. For example, each chromosome 4 has the same genes as the other 4 chromosomes, but it is not necessarily the same of these genes. Therefore, the organism received DNA from two parents with two copies of each autosome, and both X or X and Y for the sex chromosome. (Novick and Bassok, 2005; Bassok and Novil, 2012; National Research Council, 2012; (Prevost and Lemon, 2016) Adequate research shows that students have difficulty learning complex solutions in many disciplines. For example, in biology and chemistry, students often ignore sensitive information or restore inaccurate information and/or incorrectly use information with problems (Smith and Good, 1984; Smith, 1988; Prevost and Lemon, 2016). In addition, in many fields, the researchers found that experts used different procedural processes than none when solving problems (Chi et al., 1981; Smith and Dee, 1984; Smith et al.) 2013.) Smith and Dee, 1984; Smith et al., 2013). When it comes to difficulties that students have difficulty solving and the value of such skills to their future careers, there is a clear need for undergraduates to help students develop problem-solving skills (American Association for Scientific Progress 2011; National Research Council, 2012). Two types of knowledge are described in literature as important for problem solving: specific domains and common domains. Domain-specific knowledge is knowledge of specific fields, including content (published knowledge). The process, the steps used to solve the problem (procedural knowledge) and how to use the content and processes when troubleshooting (conditional knowledge; Alexander and Judy 1988). The third category of strategic knowledge refers to knowledge of strategic solutions strategies that can be a specific domain or a common domain (Chi, 1981; Alexander et al., 1988) research suggests that a specific knowledge is needed, but may not be enough to use strategic knowledge to solve problems (Alexander and Judy, 1988; Alexander et al., 1989). Previous research has suggested that receiving various forms of assistance, including step-by-step notifications (Mevarech and Amrany, 2008), a combination of content notifications and multiple step-by-step messages (Pol et al., 2008) and versions (Stull et al., 2012), can be useful for learning. (Dooling and Lachman, 1971; Bransford and Johnson, 1972; Gick and Holyoak, 1980) For example, in genetics, successful problem solvers often identify similarities between problems, while unsuccessful problem solvers do not. Previous research also suggests that being guided by step-by-step may be beneficial to learning. In the study, students asked students to examine different problems with related solutions, encouraging students to consider previously reviewed issues, helping most students solve challenging problems later. In another study, when students received recommendations that included identifying similarities with other problems, including other procedural skills, such as planning and examining their work, they could solve the subsequent problems better in the absence of such recommendations. However, although access to previous knowledge is important, it is important that students How to apply their previous knowledge to a given problem (Bransford and Johnson, 1972), so while students may realize that they need more information to solve the problem if they can't understand this information in the context of a given problem, the information is unlikely to be helpful. In addition to knowledge, students also need training. Within the field of psychology, many studies have examined the relationship between practice and efficacy. Conducting exercise tests leads to better performance in subsequent final tests compared to other conditions in which students do not test themselves, such as studying or doing unrelated or non-activity activities (such as Roediger and Karpicke, In a meta-analysis, this effect is called test results, found to occur without determining whether it has been suggested or not, and regardless of the time between the practice test and the final test (Adesope et al. 2017). In a few studies on test results, using transfer questions, students who conducted practice tests performed better in transferring questions in the final test for both facts (such as a single fact in a sentence) and concepts (such as sticky thoughts in multiple sentences). The study also found that those who performed well in their practice tests were more likely to do better than those who did poorly in their practice tests 1 week after the practice in the subsequent final test, which included the conceptual question requiring an application (Butler, 2010). We answer the following questions: 1) Does a single content-focused prompt help students answer similar questions during subsequent practices, and does this practice help in later exams? When content prompts are not available, we invite students enrolled in the Preliminary Undergraduate Genetics Course for Biology (a total of 416 students in the course) at the four-year institution in spring 2017 to perform two practice assignments with content related to the course exam. The first practice assignment occurs immediately before the unit exam, and the second assignment is performed immediately before the next unit exam or after this exam to prepare for the final exam accumulated (see also Each event is offered online (using the Qualtrics survey platform) for up to 6 extra credits (650 total course points). Students will receive 4 points for answering questions with an explanation of their problem-solving process and 2 more points if they answer correctly. Practical assignments are announced in class and by email, with encouragement to complete the assignment to prepare for the upcoming exam. Students have the option of consenting to the answers used for research, and all students who complete the assignment receive credit regardless of their consent. Students in the course were given the option to evaluate genetic concepts (GCA; GCA; Smith et al., 2008) online at the beginning of the semester (within the first week of class). For extra credit contributions. The 25 GCA questions discussed the eight learning objectives of the 11 teachings in this course. Students answer the same GCA question again in the final exam, accumulating for credit, along with questions created by the instructor, who discuss the content of the practice assignment along with other course content. The questions the instructor created in the final exam consisted of 15% of the student's final course grades, and the GCA question consisted of less than 8% of the student's final course grades. We chose a content area known as a challenge for genetics students (Smith et al., 2008; Smith and Knight 2012) and developed a series of questions on the following five topics: calculating the probability of succession in several generations (probability). Defines the inheritance pattern (gel/ pedigree). To predict the probability of genotype of the offspring using the same gene-linked (incorporation) and the determination of the parent's pathogen line, the gene stamped (stamped) for each content area, we wrote three questions aimed at isomorphic with the following characteristics: they discussed the same basic concept, but used different superficial characteristics to target higher cognitive processes, as assessed by bloom (Bloom et al., 1956) with the same number of data, and students needed similar actions to address similar problems. The question is in a generated response format, but with one correct answer, and each question also has a visual assistance tool matched (for example, in Figure 1, see all the questions in the auxiliary material). The initial question is based on exam questions previously used in the course and have been tested and edited through interviews, aloud ideas of the individual (16 students and seven faculty of genetics) and/or. Focus group (three students) Figure 1. Examples of exercise questions used for troubleshooting non-fragmented content issues. Three questions within a given content area (called trio) were given, respectively, in the practice assignment, with the first, second and third questions called Q1 Q2 and Q3, respectively. For each problem-solving assignment, we randomly for each student, a sequence of three questions in each content area and the sequence that presents each content area. In the first problem-solving assignment to prevent fatigue, students answered two-thirds of the randomly assigned content areas (probability of non-fragmentation and gel/pedigree), and for the second assignment, the students answered questions about both incorporation and seal. We develop content-focused notifications (called content suggestions) based on the general errors of students revealed during class questions and previous exams for this course and/or during interviews, each student thinking aloud. Each hint corrects the most common student error, and only a single content concept (Table 1) in each online practice assignment, we randomly assign students one of two conditions: an auxiliary content hint when answering the second question of the content trio (hint at Q2) or a hint of supplementary content when answering the third question of trio content (hint at Q3), the first question (Q1) serves as a fundamental indicator of performance for all students. In the second quarter, we compared the performance of students in two conditions to determine the impact of recommendations versus practice only. In the third quarter, we compared the performance of students in each condition to the performance in the second quarter to determine whether performance was maintained (for Q2 condition guidance) or performance improvement guidance compared to Q2 (for Q3 condition guidance) with the use of this random design, we were able to examine the different effects of practice with hints while still giving every student the opportunity to receive guidance. Table 1. Hint of space content HintRecombination the map distance between the two genes provides information on the likelihood that incorporation will occur between the two genes. The probability for auto-regressive diseases of children with two known non-diseased diseases is 2/3 probability of becoming a carrier because you know they are not a regressive homozygous gel/pedigree, The Males have only one X chromosome and make only one copy of any DNA sequence on the chromosome X chromosome nondislogous nondisctionjunReplicated corresponding to the metaphase plate in meiosis I and the chrommasis corresponding to the metaphase plate in meiase in the second quarter of 202 or 23 000. Students are asked to respond to the following: Do you need a hint to solve this problem (no penalties)? If so, click here. If they click, a hint will appear immediately below the problem so that the student can see the hint while solving the problem. By asking students to choose a hint instead of showing it to everyone, we can track who chooses to hint and distinguish between the recipient of the hint and the non-hint. We do not provide real-time feedback to students because the instructions provided are intended to act as scaffolding mechanisms without individual feedback. It is also challenging to provide feedback because the online-based platform does not allow personal feedback, and because student responses are generated and can't be automatically graded. We instruct students to explain in writing their thoughts and the steps they are taking to resolve the issue before they give the final answer for each question. (Prevost and Lemons, 2016) Students are not allowed to return to ask questions once they have responded. The instructions at the beginning of the assignment provide an example of how to do this (see more content), and students can read the instructions and examples if they need to during assignments. In this study, we tracked the performance of students and their use of language on content hints, not their thought or problem solving process. We categorize errors and omissions only for student content and the use of language associated with content hints. The two authors reviewed the student's responses to develop the default set of codes, and then we independently coded more than three times, 66 of the 456 responses selected. We wrote 19 additional answer codes to achieve the final agreement at 85% (kappa of Cohen 0.83), as we have already written the code and agreed to 19% of the student's answers at the time. This point and our agreement is above acceptable levels (Landis and Koch, 1977), and then we code half of the remaining 371 answers independently and discuss and resolve any concerns. We analyzed data from 233 students: 133 students completed their assignments, 54 students completed the first assignment only, and only 46 students completed the second assignment. In the event that the content area is not specified, we will report the results in all content areas together. We analyze

patterns in the level of an individual's answer and use logistical regression to compare the response performance between content space conditions and the progress iveive group to maintaining efficiency. One content area is independent of another content area. Student performance within a single content area for Q1, Q2, and Q3 is considered based on (e.g. repetitive measures) and we use McNemar's tests to analyze the difference in the correct percentage between questions. To monitor trends at the student level, we use regression analysis, at least square. For analysis of the use of language, student content and content errors, we do not include any trios who cannot code one answer (i.e. no problem solving the problem described: 36 In this study, we used a logistics regression to compare the presence of content-specific languages between different groups within the same hint condition. For final exam questions created by the GCA and instructors, we will report performance as a valid percentage. We exclude pretest GCA scores for individuals who spend less than 6 minutes completing an online questionnaire with GCA or not completing at least 85% of the questions for both the GCA exam and the final exam created by the instructor (including 150 points). In this study, for the GCA, the questions related to the practice include one multi-choice question, a content area joint (question 10, 20, 24, 25), a total of 8 points for the final exam created by the instructor 21. We use OLS regression analysis to examine the relationship between student assignments, practices and exam performance, and we report non-standard beta coefficients. We use the average performance to practice q3 questions (the correct Q3 practice), which is a measure of the success of the practice as a predictor. We also included average performance in Q1 (Q1 practice accuracy) for evaluation performance analysis, we examined only students who completed both practice assignments (three total content areas) to ensure that all practice predictor variables were calculated based on the same number of questions (three Q3s and Q1s) of the 133 students who completed both practice assignments, The OLS regression model is as follows for GCA and exam questions created by both instructors, related practices and unrelated practices: We also compare assessment results for students who completed GCA both time. and final exams, but do not complete any practice assignments (n = 35) with those who complete all assessments and practice assignments (through OLS or independent t tests as stated). For this analysis, the regression model of OLS is as follows for GCA exam questions and instructors created both related to unrelated practices and practices: we use Stata v. 15.0 and R v. 3.3.3 (dplyr, VennDiagram, statmod, VGAM, irr packages) for all statistical tests. Statistical significance truncates the alpha. 0.05.This work has been reviewed by the University of Colorado Institute's Audit Committee and the use of approved human subjects (protocols 16-0511 and 15-0380) by randomly answering each question within the content area, we can use the student's performance in the first question to compare the difficulty of each of the three questions. For all content areas except stamps, the question is isomorphic (χ2, p > 0.05) and answering the stampede does not influence the student's performance in the reunion question (the first incorporation question versus the second in the practical assignment; logistical regression p > 0.05),. Two hundred and thirty-three students answered a total of 553 questions (Q1, Q2, Q3), the number of trios answered varies for each content area, because not all students answered all the questions or completed both assignments: in the first assignment, students responded to trios in two of the three content areas (random assignments), and in the second assignment, all students answered three questions about the new compilation. We first examined the performance of all students in all four content areas, and then for each individual content area (Table 2) for all content combined, the performance of the students increased from question 1 (Q1) to question 2 (Q2) and 3 (Q3). In comparison, the Q1 performance between the student content areas had a higher accurate percentage for gel/pedigree questions and nondisjunction than for probability and incorporation questions and. The correct percentage for probability is greater than reunification (Table 2) Table 2. 4547Probability122505552Gel/Pedigree 127657676 Nondisjunction125767171 All students are given the option to receive content hints for each content area during the assignment practice, They only use this option in 68%. Overall Trios (Supplementary Table S1) Students who were offered a hint in the second quarter were equally likely to those offering hints in the third quarter to hint for any content space defined. Students choose to hint more often than the gel/pedigree content area that is easier. When viewing the show in all content areas combined, students who received a hint in a given trio scored lower than all three questions significantly than students who did not hint at a given trio (S2 supplementary table), while it was not always important to see each content area (supplementary table S2). This difference is also important in each content area of the new integration, but not the other content area (supplementary table S2) to maintain the appropriate sample size in our analysis, we combine all content areas together for the rest of the information in this document about performance. To best represent how students have a consistent pattern in choosing a hint, we focused only on students who answered questions in both practice assignments (up to three content areas) from the 133 students who worked on the two assignments, 14 students never chose to choose to mute 56 students, sometimes occasionally hinted at, and 63 students told when presenting. Students who have never used a hint perform better in Q1 than students who have always received a hint (Supplementary Table S3). We don't have a random process for offering hints: all students are given the option and those who don't hint choose not to do so for reasons we can't directly verify. In addition, since there are only a few students in the study choosing not to hint, and because we are primarily interested in the results of content hints about student achievement, we focus on students who receive random hints as Q2 or Q3 within the trio to detect the immediate impact of content hints on student performance, we focus on the rest of our analysis in situations where students use hints. We use Q1 as a fundamental measure of student performance in a given content area, as students were offered a hint either in Q2 or Q3. We examined the performance in Q3 for students who received a hint, we looked at the aggregate data at the individual answer level before drilling the answer into the correct Q1 versus the correct, then looked at the performance in the next two questions (Figure 2), as shown in Figure 2A. It shows that the practice itself may not help these students who responded correctly in the first place. Students who received a hint in Q2 performed the same as those who did not, indicating a decrease in performance from Q1 to Q2 was not due to a hint. In the trio given, Q3 performance was not different as when instructed, and the average performance did not change from q2 to Q3, indicating that the recommendations did not positively affect performance for these students who responded correctly in the first place. Figure 2. The effect of the hint varies depending on the accuracy. Q1 (a) Q1 is incorrect: the percentage of correct answers for Q2 and Q3 is displayed for trios, where the instructions were taken at Q2 (n= 84 trios) or at Q3 (n= 110 trios) *, p < 0.05; all other NS, p > (b) Q1 is correct: the percentage of correct answers for Q2 and Q3 is displayed for trios where the instructions were taken at Q2 (n = 89 trios) or at Q3 (n = 91 trios) there is no significant difference between conditions (logistics regression p&p). If students answered Q1 incorrectly within the trio, 21% replied Q2 correctly, without a hint suggesting that the practice alone could help these students who responded incorrectly at first (Figure 2B), however, significantly higher percentage students responded correctly when they received the third trim in the third trim, in addition to the correct hint. A similar percentage of students who received the hint at Q2 also correctly answered Q3, stating that on average they maintained performance in subsequent questions after the hint. The third question in the student content area, all of whom received some hints at Q2, and some in the third quarter, who received a hint in the third quarter, performed the equivalent of the third quarter with those who gave a hint in the second quarter, indicating that the student benefited similarly at the end of the practice of the given content area, regardless of when the hint was received. We tracked each student's progress from Q1 to Q3 (Fig 3 and 4). The percentage of people who moved to get Q2 corrected when they received the hint, then 68% of those who received Q3 were correct. So, for the most part, but not all students maintained this update from Q2 to Q3, students used a hint at Q3 in 201, trios of questions (Figure 4), from this 55% of students in the given trio incorrectly answered Q1. Seventy-nine percent of those who received Q2 were wrong, and then 26% of those moved to get Q3 correct when they received a hint. As seen in Figures 3 and 4, while hints help some students correctly answer subsequent questions, the hint does not help all students. Some students answered Q1, Q2 and Q3 incorrectly, despite the hint. Figure 3. Student progress in the trios answer, where a hint is taken at Q2, the percentage of correct answers is represented by the number of answers in each category (such as invalid Q1) in parentheses. The arrow specifies the percentage of responses tracked to the next category. Bold arrows show the types of trios that were analyzed for the use of specific language, content and error/omission: trios with Q1 are incorrect, but Q2 and Q3 are correct (group 011) and those with all three incorrect answers (group 000) Figure 4. The arrow specifies the percentage of responses tracked to the next category. Bold arrows show the types of trios that were analyzed for using specific language, content and error/omissions: trios with Q1 and Q2 are incorrect, but Q3 is correct (group 001) and those with all three incorrect answers (group 000) to explore further why the hint did not help some students, but help others, we examined how students used the given content hint. We categorize within the solution answers with the student documentation 1), the presence of the language reflects the content described in the hint (the code is current or absent; Table 3) and 2), the types of errors and omissions of the content that arise in the solution. Tracking both accuracy and language usage in three questions (Q1, Q2, Q3) For each content area (Table 4), only the following selections of students who answered Q1 are incorrect and remove hints being considered for this analysis (see thick arrows in Figure 3 and 4): Students in the given trio who answered Q2 and Q3 correctly after hinting in Q2 (meaning 011). Students who switched from incorrectly to Q1 to editing at Q2 or Q3 (students 011 and 001 respectively) often use language associated with the content of the hint more than students who answered all three questions incorrectly. In cases where students take a hint in the second quarter, 83% of In the 011 group, there were languages that reflected the hint content compared to 55% in the 000 group (n = 40 and 74 Q2 and Q3 answers, respectively; Similarly, when students received a hint at Q3, 91% of the answers in the 001 group had a language that reflected the hint content compared to 60% in the 000 (n= 23 and 60 Q3 responses, respectively; logistics regression, OR = 9.2, p&lt&0.01). Table 3. The presence of the language reflects the content in the hint criteria, the specific code in the answer during and after receiving the language hint area that scores is a reflection of the content hint, if any:RecombinationSpecific Mention the map unit and/or the new integration percentage associated with the Probability2/3 problem is the probability that the person is heterozygous (when it is known that it will not be affected). X chromosome nondisjunctionDescription of the chromosome alignment before separation (1) and/or the time of homologous chromosome separation (2) and / or time of sister chromatic separation (3)Table 4. Content error and code ignore codeContent codeDescription (in the student answer do one or more of the following for a given code). No map units are used, do not use map units to determine the incorrect probability of using map units, use map units in a novel way in a novel (e.g. multiply the map units according to the probability of Mendelian, or consider the map unit for homozygote pairs), do not divide the map unit by two to determine only one gametePerforms calculation error using gamete map unit, the error type indicates that the preferred game as a parent versus recombinant (or vice versa), determine the probability of playing the game repeatedly with the game of parent (or vice versa). No/improper use of the product rule does not use the probability of both the parent and the child to determine the possibility of phenotypeIncludes of the child,the probability of the child's gender when the sex is already known is not properly used of inheritance mode or calculation, use the wrong mode of inheritanceCombines. Error calculating pedigreeGel/no discussion of copy number, does not discuss the number of copy chromosomes in males (e.g. chromosome x one, two autosomes) and females (two X chromosomes, two autosomes) no gel pedigree is clearly used. However, obviously, using data in the gel inheritance mode is not complete, one or less components of the inheritance mode (e.g. no Both of the following: automatic with X-linked and regression vs. striking), incorrect chromosome rules, chromosome definitions/ rules, separation, definitions of chroma, mat, sister and homologuesReverses, isolation rules for homologues and sister chromatids misunderstanding divisionsDoes do not consider the meiotic division (I and II) in which errors occurDoes. Do not distinguish the meiotic divisions I and IIIncorrectly distinguish the division of meiotic I and II according to the number of gamer chromosomes, a common misunderstanding of meiosisIncorrectly, normally identified as the expected number of chromosomeAssumes. Abnormal processes or mutations must occur. (000 groups) Displays a variety of content-specific errors and omissions, including multiple errors or omissions within a single answer. Figure 5 shows these errors and omissions for Q1 through Q3 divided by content area, with each error type or omission displayed with a different color circle. For each content area, orange shading displays errors or omissions related to the recommendation content. Other colors display different errors or omissions for each content area and are not related to the hint of content. Details for each content area for group 000 are provided in the following sections. Figure 5. The number of responses that each content error/omission error code/ignore appears. There is an overlap in the color indicating multiple errors/omissions within a single answer. Only 000 progressive groups are displayed for every Q1-Q3 question in each case. In the common error integration question in the 000 group did not use the map unit to fix the problem (57% of the 143 answers; Figure 5A orange oval). In addition, students make three other types of errors, sometimes in addition to the most common errors. In some answers, while using map units, they are used incorrectly. (29%; Figure 5A blue ellipse) Students also make the mistake of incorrectly identifying the type of game in which they incorrectly assign a game type (recombinant or parent) or determine the probability of reunification to an ineffective game. (22%; Figure 5A green oval) Often, students incorrectly identify the desired genotype to solve the problem (4%; Figure 5A, magenta oval). Even after receiving a hint given the map distance determination, many students made the most common error of not using the map unit to solve the problem (no map unit use; 49% of the 67 answers), although some of these students (n = 12) used the text language content of the hint. In this study's probability question, students are required to appropriately assign offspring with a 2/3 probability for certain genotypes based on the data. Parental and inheritance modes (due to genotype, one possible offspring from parental mating are eliminated). The two most common errors in the 000 group are incorrectly assigned genotypes or probability (this includes not using 2/3 probability correctly, 81% of 67 answers; Figure 5B orange circle) and does not use or use incorrect product rules for multiple probability independent multipliers (64%; Figure 5B green circle). These two errors often appear together in the same answer (40%; Figure 5B), while the student's answers are sometimes an error of using inheritance mode or incorrect calculation, either alone or in combination with other errors (21%; Figure 5B blue circle). Even after receiving a hint about the probability of 2/3, many students make incorrect genotypes or probability assignments (Genotype/probability misassignment; Although some of these students (n =5) used the language, the content of the gel/pedigree hint was one of two types of higher efficiency (the other was nondisjunction), so there were fewer answers in these 000 groups, students interpreted both gel and pedigree to determine the inheritance pattern. The omission of not to mention the number of genes per gene in males and females is most common (91% of the 23 answers; Figure 5C orange circle), and while there are only a few answers that contain this single omission, many answers, in addition to this omission, in addition to the errors/other omissions of the gel clearly provided (include 57% figure, 5C green circle, incomplete) and incomplete succession mode assignments (including 26% figure 5C blue circle). Even after receiving a hint about the number of X chromosomes, many students made the most common omission of not to mention the number of genes per gene in males and females (no discussion of copy numbers; 88% of 8 answers), and none of these students used the language content of the hint. In the assembly issue, students were asked to identify the cause of the incorrect number of chromosomes after meiosis, three errors in understanding meiosis had a similar level in the answer in the 000 group, including students who described homologues with chromatic sisters and/or in the distance they separated at metaphase plates (30% of 33 answers; Figure 5D orange circle). Students do not adequately understand that the procedure should be considered in meiosis (I or II) and different (42%; Figure 5D green circle) and the student does not understand the general results of balm or potential errors (33%; Figure 5D blue circle). After receiving a hint that explains Many students still make the mistake of describing homologues with chroma addicts and/or at what stage they separate in meiosis (incorrect chromosome definitions/separation rules; 38% of 13 answers), although some of these students (n = 3) use the language, the content of the hint. In addition to the immediate impact of recommendations on the performance of students during practice assignments, we also examine whether the practice itself is related to long-term performance in the final exam. จากนักเรียน 233 คนที่เสร็จสิ้นการมอบหมายการปฏิบัติ 133 เสร็จสิ้นการมอบหมายงานทั้งสองและ 100 เสร็จสิ้นการมอบหมายเพียงครั้งเดียว เพื่อให้แน่ใจว่าตัวแปรตัวทำนายการปฏิบัติทั้งหมดถูกคำนวณตามจำนวนคำถามเดียวกัน (สาม Q1s และ Q3s) เรามุ่งเน้นเฉพาะนักเรียนที่เสร็จสิ้นการมอบหมายการปฏิบัติทั้งสอง จากนักเรียน 133 คนที่เสร็จสิ้นการมอบหมายงานทั้งสอง 109 ของนักเรียนเหล่านี้เสร็จสิ้นการสอบ GCA ก่อนและหลังและผู้สอนที่สร้างขึ้น: นี่คือนักเรียนที่รวมอยู่ในการวิเคราะห์ขั้นสุดท้ายที่รายงานในตารางที่ 5 และตารางเสริม S4 และ S5 การใช้ประสิทธิภาพเฉลี่ยในคำถามการปฏิบัติไตรมาสที่ 3 เป็นการวัด ความสำเร็จ ในงานมอบหมายการปฏิบัติ (เสริมตาราง S4) เราพบว่าสำหรับนักเรียนที่เสร็จสิ้นการมอบหมายการปฏิบัติทั้งสองความสำเร็จในทางปฏิบัติอย่างมีนัยสำคัญคาดการณ์ทั้ง GCA posttest และผู้สอนสร้างประสิทธิภาพคำถามสำหรับคำถามที่เกี่ยวข้องกับการปฏิบัติ (การควบคุมสำหรับประสิทธิภาพเฉลี่ย Q1 และประสิทธิภาพ GCA pretest; ตารางที่ 5 รุ่น 1 และ 2) นักเรียนเหล่านี้ยังมีคะแนนที่สูงขึ้นอย่างมีนัยสำคัญในคำถาม GCA ที่ไม่เกี่ยวข้องและผู้สอน (ตารางที่ 5 รุ่น 3 และ 4) ตารางที่ 5. การประมาณการการถดถอยของ OLS ของความสัมพันธ์ระหว่างประสิทธิภาพการปฏิบัติและประสิทธิภาพการสอบขั้นสุดท้ายที่เกี่ยวข้องกับ β (SE) การปฏิบัติที่ไม่เกี่ยวข้อง β (SE) GCA posttestInstructor สร้างการสอบขั้นสุดท้าย GCA posttestInstructor-สร้างการสอบขั้นสุดท้ายModel1234Practice Q3 ที่ถูกต้อง (%)0.24** (0.08)0.29*** (0.07)0.16*** (0.04)0.16** (0.05)ฝึก Q1 ถูกต้อง (%)0.16 (0.08)0.06 (0.07)0.12** (0.04)0.09 (0.05)GCA pretest (%)0.32* (0.16)0.30* (0.13)0.28*** (0.16)0.30* (0.13)0.28*** (0.16)0.30* (0.13)0.28*** (0.16)0.30* (0.13)0.28*** (0.16)0.30* (0.13)0.28*** (0.16)0.30* (0.13)0.28*** (0.16)0.30*.07)0.25* (0.10)ปรับ R20.26970.30770.48780.2767Finally เราตรวจสอบว่ามีความแตกต่างในผลการสอบครั้งสุดท้ายระหว่างนักเรียนที่ไม่เสร็จสิ้นการมอบหมายการปฏิบัติใด ๆ และผู้ที่เสร็จสิ้นการมอบหมายทั้งสอง มีนักเรียน 35 คนที่ไม่ได้มอบหมายการปฏิบัติใด ๆ แต่เสร็จสิ้นการสอบ GCA ก่อนและหลังและผู้สอนที่สร้างขึ้น We use pretest GCA scores to control potential differences in incoming genetic knowledge between a group of students who complete no practice assignments and those who finish, even if we can't control other factors such as motivation or attention. There was no significant difference in GCA test scores between these two groups. But students who completed practice questions had higher GCA test scores and final exam scores created by the instructor than untrained students (Supplementary Table S5). This gives students the opportunity to struggle through the first question for each concept on their own before they get help. The first fight without help, followed by feedback, has been shown to help show the future of students (Kapur and Bielaczyc, 2012), and although we do not give students feedback that they are correct or incorrect in their initial answers, we give all students the opportunity to get scaffolding through a hint of content. For students who responded to Q1 incorrectly at first, when they received a hint of content while answering Q2, 37% responded correctly, while only 21% of students answered this question correctly, if they didn't give a hint in the second quarter, this difference of 16% indicates that although practice alone can help, practicing content scaffolding will help more students. In addition, we have shown that students benefit from a hint of content without notice, whether they receive that hint in the second question or the third question. This suggests that students who learn from the clues in the second quarter can use this knowledge to answer the next question. Once they receive important content, students who use the hint successfully to continue doing so on future issues. Not all students in this study chose to use the proposed hint when tackling the practice. Students who did not give a hint for a particular trio had a higher Q1 score than students who received a hint. In addition to these fundamental differences in performance, several possible factors may influence a student's choice. One element you choose students may relate to their ability to self-control to monitor their understanding (Aleven et al., 2003). In a study that examined the use of three-dimensional molecular models of students to help draw molecular representatives, some students did not use the model, although the models were placed directly in their hands (Stull et al., 2012). Students who do not use the provided instructions may feel they do not need them. In contrast, 29% of the students in our study who did not hint at answering the first question incorrectly showed that their conviction was misplaced. Similarly, in studies that offer computer-friendly recommendations for problem solving, even students who predict educators will benefit from the recommendations, not always taking them. In the current study, due to the generated response characteristics of the question, students could not receive immediate feedback on whether they answered the question correctly or not. Therefore, it is valuable to check whether immediate feedback on performance will affect the future selection of students. Since we can't discover the reasons for students not to hint at this study, we can't draw more conclusions about their choices. We showed that combining a single content concept as a hint helps some students struggling to initially understand potential concepts by enabling their previous knowledge related to hint content. To look at these student solutions, we found that students who improved in content defined trio (011 and 001 groups) often used language similar to the content of the hint rather than the students who responded incorrectly in the given trio (000 groups). Added to the previous framework (Alexander and Judy, 1988; Alexander et al., 1989) We recommend that this published knowledge (content) be an element of domain-specific knowledge needed to use the knowledge in steps (such as strategies) to solve the problem correctly. In future studies, we plan to explore the details of the student's next step process during the resolution, and to determine whether students can not restore data as the main reason for incorrect answers or have higher cognitive skills and processes for correct solutions. Some students continue to incorrectly answer all questions in trio content (000 groups), despite the content hint. These students often have multiple gaps in content knowledge or make errors or omissions of content unrelated to content hints. In future studies, students will be given content recommendations optimized to match all the errors available. This may allow us to determine whether a lack of content is the cause of the wrong answer, rather than a lack of procedural skills. In previous studies, computer programs for problem solving that provided tailored recommendations and recommendations were used to help solve specific genetic problems, providing up to four recommendations for each given element of the problem (a genetic cognition tutor; Corbett et al., 2010). Found important improvements to learn from before the completion of this program. In case the student replied incorrectly (000 groups) Some of the language used involves hinting content, but make mistakes when trying to use a hint in their description. If a student has incorrect knowledge about how to apply the content, even if there is a valid content concept, the instructions may not be enough. In fact, Smith (1988) found that unsuccessful problem solvers often were able to identify important information, but didn't know how to use it. In this case, giving students more scaffolding, for example, by providing examples of the work of students with similar problems (such as Sweller and Cooper, 1985; Renkl and Atkinson, 2010) or giving additional advice and feedback through cognitive tutors (such as Corbett et al., 2010) may be required. These students who consistently respond incorrectly may lack important problem-solving skills. In this study, we focused on the use and application of content knowledge, but in future studies we will examine the problem-solving process that students respond to correctly and compare these with the processes used by students who responded incorrectly. Certain skills can be extremely important, such as expressing their ability to spread (knowledge and self-control). Enabling previous knowledge by identifying similarities between problems is an effective metabolic skill to help reorient yourself to problems (Gick and Holyoak, Meijer et al., 2006), and use this behavior in conjunction with other metacognitive skills, including planning and monitoring work, can improve the ability to solve problems (Mevarech and Amrany, 2008). For the topic of continuously incorrect student reunification (group 000), they often do not use the map unit to determine the probability of the offspring when considering two linked genes, but many students try to solve the problem by using punnett squares and/or the logic of the probability resolution for different chromosome genes. This suggests that the concept behind calculating the probability of inheritance using linked genes is challenging. Students struggle to calculate the probability that children who are not affected by two heterozygotes will be heterozygote, rather than considering information in the pedigree that will help them eliminate one of the possibilities of genotype. Students often assume that the probability of heterozygote offspring of the carrier will be 1/2 rather than 2/3 for students who answer these questions are not consistently accurate (000 groups). The most common errors include a combination of a 2/3 non-use probability with a failure to properly apply product rules to multiple versions of accounts. This suggests that students' struggling students do not understand the broader concept of how to consider multiple generations when determining probability, and therefore have difficulty combining multiple concepts with their solutions. Indeed, previous work shows that many students have difficulty using these two types of calculations (Smith, 1988; Smith and Knight, 2012). Students who consistently respond incorrectly (000 groups) Show difficulty reading the gel to identify the number of allele copies, and then connect this information to the pedigree. In this course, students are taught that although the gel is not always quantitative. Despite being taught this convention, students still have difficulty using the concept of both allele number (eg, only one X allele chromosome for men) and the amount of DNA (eg, thick bands represent two of the same alleles for each individual). Therefore, students need additional training to understand the concept of interpreting information about gels. In non-discriminatory questions, students who answered incorrectly (group 000) had a variety of misconceptions about meiosis, with the three most common errors. The unscripted question asks students to clearly identify the term in meiosis if they are affected. However, students often fail to determine whether a meiotic division, I or II, errors may occur, or they show uncertainty about the difference between the two stages of meiosis. But they are often wrong. The third error that a student makes represents a common misunderstanding of meiosis, in which a student identifies the number of individual chromosomes that should be in the game, or the student assumes that inappropriate events such as multiple replications must occur to produce a game with one special chromosome. Previous work on this topic also found that students demonstrated numerous errors when demonstrating meiosis, including incorrect chromosome alignment during metaphase (Wright and Newman, 2011; As well as previous studies that report on test results (e.g. Adesope et al., 2017; Butler, 2010), the report on test results (e.g. Adesope et al., 2017; Butler, 2010), The New York Times, Anderson Cooper, Anderson Anderson, It was found that the practice was later linked to performance assessment. Regardless of Q1 practice, performance and performance testing, GCA tests pretest, students' success in practice predicts the long-term performance of students, both relevant practices and unrelated practices in the instructor's final exam scoring and score. GCA in the course We also showed that those students who completed both practice assignments performed better than students who did not complete any practice assignments, controls for pretest GCA test performance. Other factors shown associated with success include student motivation, attention and metacognition (such as Pintrich and de Groot, 1990; Schiefele et al., 1992; Also and Fry, 2008). Our study discusses four important aspects of genetics that we know students are struggling with. However, students may have additional or different problems in other genetic content. In addition, these questions have only one valid answer and may be limited. Ability to test students' problem-solving skills In the future, we want to examine more bad questions with several possible solutions (National Research Council, 2012). While we expect that most students will use the option to receive a hint, only 68% of students will be able to provide an accurate representation of the influence of the hint we need. Limited Our analysis to those who chose to use the hint, as seen in Stull and colleagues (2012), worked on the use of molecular models and, according to our data recommendations, to monitor the use of language, the content reflected in the hint, not all students were more likely to take the instructions, even if the recommendations were readily available. However, it will be interesting to know why students choose not to take a hint of that decision, and this decision is based on high confidence or fear that a hint may confuse them. We also can't directly test whether students who receive a hint perform better than those who don't use hints in long-term performances, since the only way to measure this is to randomly do the students who do and don't get a hint. We choose not to use this method because we feel it is important for the success of students to give everyone access to the same information. This study suggests that after learning the topics in a subset of students who begin to give the wrong answers to problems in these topics, they can be improved after receiving a single content concept that may fill the knowledge gap. Some students may understand these solutions, but lack one or two pieces of information. Providing missing parts allows them to use their knowledge and solve problems. These students reviewed some of the genetic content, which we described in this study, may be enough to help them solve them properly. In addition, we recommend highlighting the importance of coaching, as this study shows that success at the end of practice predicts long-term effectiveness in the classroom, regardless of the initial understanding of genetics topics. This can be beneficial to the learning of students (Kapur and Bielaczyc, 2012), students who are still struggling despite hints the content tends to lack content knowledge, including problem-solving skills. We plan to further monitor such deficits in how students solve problems, so that feedback focuses on the logical steps and metacognitive processes needed for solving the problem. This work is supported by the National Science Foundation (DUE 1711348), we thank Oscar Whitney for help developing and testing preliminary questions, and Ashton Wiens and Felix Jimenez for their help in statistical analysis. We are also grateful to Paula Lemons, Stephanie Gardner and Laura Novick for their advice on the project and all the students participating in this study. RefAdesope, O.O., Trevisan, D. A. and Sundararajan, N. (2017) Review of The Use of Testing: Meta-Analysis of Practice Tests Google ScholarAleven, V., McLaren, B., Roll, I., & Koedinger, K. (2006) Towards Learning Meta Teaching: A Form of Help Seeking with A Cognitive Tutor International Journal of Artificial Intelligence in Education, 16, 101–130 Google ScholarAleven, V., Stahl,., Schworm, S., Fischer, F., & Wallace, R. 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