INTRODUCING THE CARD EDITING APPLICATION OF THE LIMSTROM DIDACTIC GAME[1]

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Abstract

Game-based learning plays an important role in all education and learning processes, including higher education nowadays. In the course, Mathematical Analysis, offered during the first semester, all students studying informatics learn about sequences of real numbers, convergence, and limits. These concepts are of key importance to understand advanced mathematical concepts and successfully complete advanced courses. Based on the benefits of game-based learning we came up with the idea of LimStorm that helps study groups of 4-10 students to learn and practice the limits of sequences of real numbers. In our paper we introduce a self-developed application which is suitable for generating decks of mathematical didactic card games, for example the deck of LimStorm.

Keywords: *game-based learning, didactic game, active learning methods, limit of the sequence, card games.*

1. Introduction

The use of didactic games in education is not a new idea, but with the rise of gamification and game-based learning (GBL), this teaching method has gained new popularity. In recent years, a number of studies have been published on specific didactic games and techniques that can be used in teaching specific subjects or topics.[2] There is a clear trend towards a more student-oriented approach, which makes the educational palette in almost all areas of higher education more varied.[3] Gamification, serious games and game-based learning are all didactic methods that can be used effectively in all segments of education. Experience shows that Generation Z students are eager to participate in testing and piloting gamified educational content.[4] In addition to game-based solutions based on ICT tools, we believe that it is important to use, develop and create traditional didactic games as well.[5]

When speaking about the learning process, we essentially design the learning experience of the students, i.e. we focus on two areas: what happens in class and what happens at home. When using didactic games, we need to focus on the same two segments. In the case of didactic games requiring specific tools, it is an advantage to be able to provide students with a teaching tool that they can incorporate into the learning process, either during home learning or during the small group preparation that is so typical of Generation Z.[6] Digital or traditional card games that do not require lengthy preparation, have easy-to-learn rules, and provide fast, dynamic play, are fun and educational at the same time.[7] Experience has shown that in addition to the transfer and practice of knowledge, the incorporation of games in the teaching process can improve logical thinking, memory, concentration, analytical, problem solving, and time

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[2] VANKÚŠ, Peter: *Didactic Games in Mathematics*, KEC FMFI UK, Bratislava, 2013.

[3] KÖREI Attila, SZILÁGYI Szilvia: *Didaktikai játékok integrálásának lehetőségei a felsőoktatásban,* Multidiszciplináris tudományok, 2020/10. 221-232.

[4] JASKÓNÉ GÁCSI Mária: *Gamifikáció a pedagógiában*, Mesterséges Intelligencia 2020/2(1). 83-91.

[5] KÖREI Attila, SZILÁGYI Szilvia, TÖRÖK Zsuzsanna: *Integrating Didactic Games in Higher Education: Benefits and Challenges*, Teaching Mathematics and Computer Science, 2021/19(1). 1-15.

[6] KORDAKI, Maria, GOUSIOU, Anthi: *Digital Card Games in Education: A Ten Year Systematic Review,* Computers and Education, 2017/109. 122-161.

[7] COTTER, Joan A.: *Math Card Games: 300 Games for Learning and Enjoying Math,* Activities for Learning, Inc., Madison, 2010.

management skills. Students learn to work in groups and develop collaboration and cooperative skills.[8]

In engineering and information technology programs in higher education there is also a need for new methods.[9] The problem is that there is a lack of appropriate tools and special didactic games that can be used for help students to master the mathematics curriculum of BSc courses in a playful way and the number of applications that can be used to create educational tools and games is also few.

In this paper, we present a self-developed card-editing application to create cards with mathematical formulas for a traditional card game. As an example, we present the LimStorm didactic card game deck, which was created to practice the notable limits of real number sequences for groups of 4-10 first-year students in engineering and computer science.[10]

2. State of the art

All engineering and computer science courses include a course on mathematical analysis as a core subject, so the concepts of sequence, convergence and limit are introduced to all first-year engineering and computer science students during their first semester, as limit and limit transition are fundamental concepts in analysis. Various techniques for understanding the definition of the limit of a real number sequences have been developed by researchers in the field of educational methodology.[11,12] It is an old research topic with a large body of literature, given that the understanding and skillful use of limit concepts strongly influences advanced studies in mathematics, physics and chemistry. Therefore, the gamification of the concept of limit value and its calculation is a significant milestone in the game-based learning of mathematical analysis.

Kapp et al. argue that there are two types of gamification in education: structural and content gamification.[13] Structural gamification is the term used when we apply game-elements to take the students through the content of the curriculum without altering the content itself. It means that the content itself is not game-like, only the structure is changed in order to motivate the student to propel through the content and make them engaged in the process of learning. Content gamification offers a different perspective. It applies game elements and game thinking to alter an educational content. It uses game mechanics such as storytelling, or challenges to grab the attention of the students and to immerse them in the learning process.

The boundary between game-based learning (GBL) and content gamification is blurry; in many cases it is hard to classify a method into strict categories. Didactic tools that support game-based learning have proven to be a significant support in keeping students' attention and interest, as one of the keys to motivating Generation Z students is play.[14] Following the new educational trends, small group teaching is gradually replacing the traditional, frontal teaching in engineering and IT higher education, which creates a suitable environment for the implementation of GBL. GBL requires games. In some cases, a well-known card game or board game can be used almost without modification for teaching purposes, but in most cases a specific didactic game needs to be created specifically for the subject material. The card game LimStorm was created to implement content gamification and GBL to help the students to understand and calculate the limits of real number sequences. The idea for the didactical game LimStorm was inspired by a popular card game, *Solo*. In many respects, we have not changed the model game, for example, we have used the same four basic colors (red, yellow, green, blue) for the deck, but we have replaced the numerals with limits and added a fifth color, turquoise, to create more series. In the second phase of the testing period, we explored a wider use of the LimStorm deck, gathering additional game ideas and looking for ways to play the game alone.[15]

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[8] DUDÁS Márk, LENGYELNÉ SZILÁGYI Szilvia, PILLER Imre: *Az Ékkővadászok elnevezésű matematikai készségfejlesztő kártyajátékok létrehozását támogató alkalmazás bemutatása,* Gradus, 2019/6(4). 17-27.

[9] FOSS, Bjarne A., EIKASS, Tor I.: *Game Play in Engineering Education – Concept and Experimental Results,* International Journal of Engineering Education, 2006/22(5). 1043-1052.

[10] KÖREI Attila, SZILÁGYI Szilvia: *LimStorm – A Didactic Card Game for Collaborative Math Learning for Gen Z Students*, In: AUER, M. E., RÜÜTMANN, T. (eds.): *Educating Engineers for Future Industrial Revolutions, ICL 2020, Advances in Intelligent Systems and Computing,* Springer International Publishing, 2021/1328. 452-463.

[11] ROH, Kyeong Hah: *How to help students conceptualize the rigorous definition of the limit of a sequence*, Primus, 2010/20(6). 473-487.

[12] CORY, Beth L., GAROFALO, Joe: *Using dynamic sketches to enhance preservice secondary mathematics teachers' understanding of limits of sequences,* Journal for Research in Mathematics Education, 2011/42(1). 65-96.

[13] KAPP, Karl M., BLAIR, Lucas, MESCH, Rich: *The Gamification of Learning and Instruction Fieldbook: Ideas into Practice*, Wiley, New York, 2014.

[14] MOHR, Kathleen A. J., MOHR, Eric S.: *Understanding Generation Z Students to Promote a Contemporary Learning Environment,* Journal on Empowering Teaching Excellence, 2017/1(1). Article 9.

[15] SZILÁGYI Szilvia, KÖREI Attila: *Using a Math Card Game in Several Ways for Teaching the Concept of Limit,* In: AUER, Michael E., HORTSCH, Hanno, MICHLER, Oliver, KÖHLER, Thomas (eds.): *Mobility for Smart Cities and Regional Development - Challenges for Higher Education: Proceedings of the 24th International Conference on Interactive Collaborative Learning*, *ICL 2021,* Springer International Publishing, 2022/389. 865-887.

The first test pack was printed in October 2019, not yet in print quality. The rules of the LimStorm game were reviewed using the test pack. During the pre-testing process, some cards were replaced, and the idea of new action cards was born. For example, the multi-functional *Four-leaf Clover card*, which can be played to request a round of card swaps or reverse the direction of play. It can also be used as a suit request card. In an alternative version of LimStorm, it can be used to initiate a *Lucky Draw*. In the LimStorm deck, all action cards are rainbow-colored. Compared to the original game, the rules have also been modified in order to make the LimStorm game as didactically sound as possible.[16] The deck reached its current composition in the spring of 2020, when we ordered three packs of cards from the printer, for which we created the cards in a print-ready version using a Java application. *Figure 1* shows the cards of an expanded deck.

The LimStorm game is a 110-card deck with 40 extra turquoise cards. The 80 colored base cards contain the limits of real number sequences that can be calculated by heart with a little routine, plus 30 action cards and 40 extra cards. The base cards are yellow, green, blue and red, and the extra cards are turquoise (see Fig. 1.). All cards have purple backs.

Fig. 1. Cards of the LimStorm deck

On the base cards there are 10 real number limits per color. The deck contains 2 of each base cards. By knowing the notable limits, and/or applying the theorem on the operational properties of the limit and the squeeze/sandwich theorem the limits on the cards can be calculated by heart. In each sets, two of the ten sequences are divergent: one diverges to +∞ and the other to -∞. Eight more have finite limits. We have placed two zero sequences in each sets to emphasize their importance and make the game more complex. We included not only the Euler number, but also its reciprocal in the limits written on the cards, so we included an irrational number in the limits to be calculated. For all four colored sets, the limits to be calculated are the same. With few exceptions, the problems on the cards contain operations and can be calculated using the limits of two or three notable series. The turquoise cards can be used to add variety to the game by increasing the difficulty level in several steps, depending on the cards chosen.

To create a deck of cards, we have first turned to the existing options available to create a printable deck of cards. For example, the *Cardgame Toolkit* online application (see Fig.2.) offers many useful features, but has a major drawback: it does not handle mathematical formulas well. No registration is required for the *Cardgame Toolkit* website, and after logging in you can immediately create a deck of cards based on the built-in templates. You can choose the layout of the card, the color of the frame, the pattern, the size, type and color of the letters used. In addition, you can view cards previously created by others. If the user wishes to create his/her own deck of cards, he/she can do so immediately by clicking on "CREATE DECK". You can also choose the look and type of the front as well as the back. The selected front and back will then be displayed side by side on the page, where the editor can add text or images.

[16] KÖREI Attila, SZILÁGYI Szilvia, TÖRÖK Zsuzsanna: *Az informatikus hallgatók tanítási-tanulási folyamatának javítása játékalapú tanulással, a LimEszelős didaktikai játék fejlesztésének és eredményeinek bemutatása,* Multidiszciplináris tudományok, 2022/12(1). 28-45.

Clicking on the "Add To Deck" icon will add the edited card to the deck being created. The test deck for LimStorm was created using this application, with the mathematical formulas pasted as images on the cards. The prototype was therefore very complicated to make. First, we had to create the formulas of the limits, save them as images, and then individually paste them on the 40 different cards that make up the deck. For the action cards, we only had to upload the images, there were no difficulties. However, the difficulties in handling mathematical formulas clearly showed that this program is not suitable to create a mathematical skill-building game. Another shortcoming of the application is related to saving, since clicking on the "Save Deck" icon only creates a saved version for the program, which cannot be edited after saving, and we must give up our copyright as well.

Fig. 2. The Cardgame Toolkit interface

After much searching, trial and error, we created a custom card-editing application based on the *Cardgame Toolkit* and *Solo*.

3. Methodology and aims

In the development of the application we used the classical waterfall model.[17] The waterfall model (see Fig.3.) is a linear, sequential approach to the software development lifecycle (SDLC) that is popular in software engineering and product development. This methodology is preferable when the concept does not change during the development process, i.e. the tasks are well defined and distinguishable before the software is built, and can be divided into sequential steps. The waterfall approach has at least five phases, which follow each other in a strict linear order. A new phase cannot start until the previous phase has been completed. The specific names of the steps of the waterfall vary, but the inventor of the waterfall model, Winston W. Royce, originally defined them as follows[18]:

- Requirements: The most important aspect of the waterfall methodology is that all requirements are gathered at the beginning of the project, which allows all subsequent phases to be planned without further consultation until the software is ready. It is assumed that all requirements can be collected at this stage. The first phase of the waterfall model is therefore entirely focused on the software design and the preparation of the subsequent phases. The success of this methodology depends on the ability to analyze all the expectations and requirements of the software before the design phase.
- Design: The design phase of the waterfall process is divided into two sub-phases: logical design and physical design. In the logical design sub-phase, possible solutions are proposed and theorized. In the physical design sub-phase, these theoretical ideas and schemas are translated into concrete specifications.
- Implementation: The implementation phase is when programmers process the requirements and specifications from the previous phases and produce the actual code.
- Verification: In this phase, we test the application to make sure it meets the specified requirements.

[17] BLOKDYK, Gerardus: *Waterfall Model - A Complete Guide - 2020 Edition*, 5STARCooks, 2021.
[18] JONASSON, Hans: *Determining Project Requirements.* Auerbach Publications, 2008.

- Maintenance: In the maintenance phase, the application is in routine use. If errors occur during operation, they will be corrected.

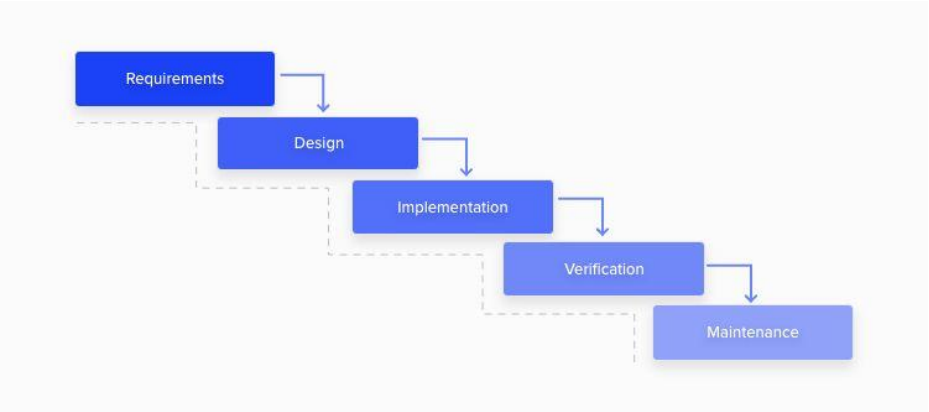

Fig. 3. Phases of the traditional waterfall model[19]

Since the primary goal of the application is to create a deck for developing mathematical skills, one of the most important aspects of the development was to embed a text box supporting the LaTeX format. LaTeX is a text formatting system based on TeX, created by Leslie Lamport. [20] LaTeX allows users to typeset and print their work in the highest typographic quality, with a predefined, professional layout. LaTeX is nothing more than a macro package, a collection of TeX commands. TeX is a word processing and text formatting program created by American mathematician Donald E. Knuth. [21] LaTeX, together with its add-ons, is completely free and open source, so it is available to anyone. LaTeX is also unique in its capabilities, having been in continuous development for over 40 years. It is device-independent, meaning that it can be used on most computers and operating systems.[22] The document created by LaTeX is identical for all editors and software environments, so the appearance of the document does not depend on the version or the compatibility level of different word processors. Writing mathematical formulas is very simple in LaTeX. [23] LaTeX can produce a wide variety of print-quality work, but it really shines in scientific and mathematical writing. [24] Mathematical journals now work only with LaTeX; a manuscript is accepted only if the author has prepared it in LaTeX. For its advantages, we have chosen to include LaTeX commands in the input fields of the card-editing application.

Another important feature to include was the options of saving the completed decks to the database and to integrate the print-ready printing option into the application. It was also essential to be able to save the finished deck in an editable version, so that the user could edit a single card within the deck without having to start the whole process over. This feature is a great advantage when the test period reveals that some changes are necessary. The users may change a few cards; they do not need to recreate the entire deck. It was also necessary to allow the user to save his/her deck to a location of his/her choice. In addition to the basic features, we've also implemented many new ideas in the app that make the process of editing easier and faster. During the implementation of the application, a number of additional requirements were formulated in terms of content, functionality and appropriate operating conditions. While the primary focus during development was to create a deck for the LimStorm game, we have always strived to have an application that can generate decks for other games as well.

During the design phase, the tasks to be solved were divided into the following parts:

- design and layout of the front and back of the cards;
- solving the problem of storing the cards;
- allowing the text box to be embedded on the cards;
- integrating LaTeX into the program and pasting the text onto the cards;
- solving the problem of saving the edited cards to a PDF file;
- enabling saving in print-ready format;
- enabling the saving of editable versions of the finished deck to a file;
- creating the menu system.

[19] https://www.replicon.com/polaris-psa/waterfall-project-management [2023.04.04.]
[20] LAMPORT, Leslie: *LaTeX: a document preparation system,* Addison-Wesley, Massachusetts, 1986.
[21] KNUTH, Donald E.: *The TEXbook*, Computers and Typesetting, Volume A, Addison-Wesley, Massachusetts, 1984.
[22] WETTL Ferenc, MAYER Gyula, SUDÁR Csaba: *LaTeX kezdőknek és haladóknak*, Panem, Bp., 1998.
[23] GRATZER, George A.: *Practical LaTeX,* Springer International Publishing AG, 2014.
[24] CSÁRDI Gábor: *LaTeX nem túl röviden*, BME, 1998. https://math.bme.hu/latex/dl/latex69.pdf [2022. 05. 17.]

With the Eclipse integrated development environment, written in Java, we aimed to create a generic application to produce cards for mathematical skill-building card games quickly. Eclipse is an open-source, platform-independent Java-based software framework. It is primarily used to develop applications written in Java, but by installing appropriate plug-ins, it can support other programming languages. It makes writing Java code fast and convenient. Eclipse highlights keywords in different colors to make the code easier to follow, has code completion and code generation features, and detects syntax errors. In the implementation phase, the first version of the program was completed.

The application was tested manually. We tested the page builder application from several aspects, created test decks with the card types needed for the LimStorm game. Most of the bugs were related to saving, these were fixed. By correctly generating and successfully saving the entire LimStorm deck, the program proved that it can meet the goals set at the beginning of its development. In the next section, we present the card generator application from the users' perspective.

4. The user interface of the card-editing application

The user interface of the application is in Hungarian. Successful launching of the application is indicated by the Main Menu window shown in Fig. 4. The dimensions of the Main Menu are fixed, the interface cannot be resized, but it can be moved around the screen, it does not have its own header. The menu offers three options.

To make an alternative version of the Solo deck we needed fronts and backs. These cards were created using the free image editing software GIMP. Five colors were used to create the deck. The background of the front cards can be yellow, red, blue, green and turquoise. We added turquoise to the four basic colors after printing the first test deck. We saw this as a way to give more scope for differentiation in the game. For the back, we can choose between purple, black or turquoise. The same fractal gives the pattern for the front and back, only the color is different. The cards of the deck are divided into two groups. The editable cards allow you to enter formulas in a white ellipse tilted at a 45° angle. The editable cards are structured as a front card image, an input field and a checkbox.

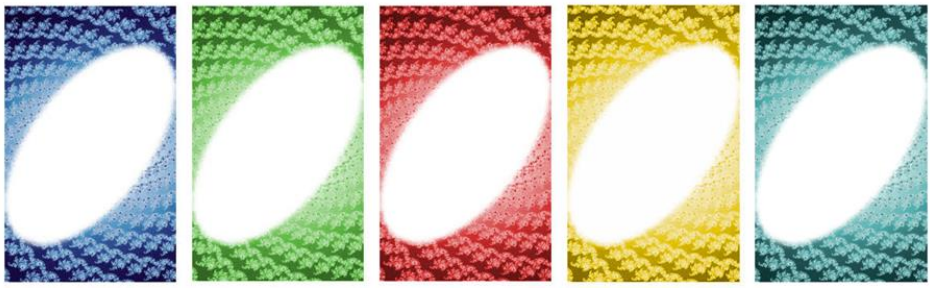

Fig. 4. The front images the editable cards

For the non-editable sheets, only the graphics were created, so only the number of pieces could be changed in the application. Accordingly, the *Main Menu* contains two menu items in addition to Exit.

One is the *Card Editor*, and the other is the *Additional Cards*, as shown in Fig. 4. Clicking on the *Card Editor* button will display the editable cards arranged in a 4x30 matrix. There are 4x20 basic cards (red, blue, green, yellow) and 40 extra cards in turquoise on which you can write commands in LaTeX format. The formulas entered are displayed formatted and rotated at a 45 degree angle. A function is used to rotate the input text, which is specified in radians using a variable that rotates the text counterclockwise. The *Card Editor* window can be resized and positioned. You can put it on the taskbar or open it to full screen or close it. You can resize this area as you like using the mouse and, if you wish, a horizontal slider will appear at the bottom of the window. The position of the menu bar is fixed, so it remains visible even when the vertical slider is moved. There are exactly four cards in a row, regardless of the size of the window. The same card is shown twenty times without a caption, but each card can have a unique caption, so it is necessary to line up all the cards. It makes it easier to build a deck if you see cards from the same series next to each other. The vertical scroll bar also helps to display previously edited cards when building the deck. Each editable card has a text box below the card in question, as shown in Fig. 5. These are accompanied by the instruction "*Type... then Enter*" before starting to edit the page. By clicking with the left mouse button, this instruction disappears, the prompt appears and we can type the LaTeX formatted formulae, and after pressing Enter, the image of the formula for the correctly entered command line appears on the card.

Fig. 5. The main menu of the application

If you misspell the instruction, the program warns you with an error message. Once you accept the information in the pop-up window, you can correct the text field and the formula will be updated after you press *Enter*. You can correct the expression you have already entered as many times as you like and work with any number of characters. This feature supports immediate correction of errors. To edit the pages, the user needs to have a minimum knowledge of LaTeX. The command \lim_{n\to\infty} does not need to be typed in the input field because it is burnt into the program, it is sufficient to type the following commands, as shown in Fig. 6. This is a convenience feature that should be disabled in case no limits are placed on the cards.

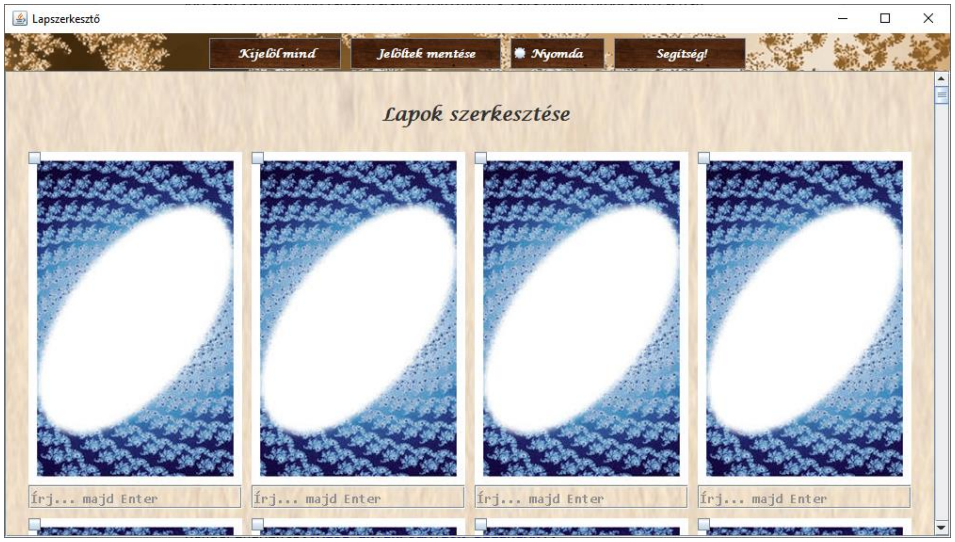

Fig. 6. The Card Editing page

The LaTeX commands written in the field had to be made interpretable by the program. To do this, we used the jlatexmath-1.0.7 external function library. The processed text was stored in a variable of type BufferedImage and displayed as an image in a JLabel on the page.

Within the Card Editor, all 120 cards have their own checkbox, in the top left corner. This is not part of the layout of the cards, it is only necessary for the program to work, because only the cards that are marked with a tick are saved in the deck. Mathematical formulas can be assigned to cards without a tick. Cards with formulas can be saved using the *Save Marked* button in the top menu bar. The cards of the deck (see Fig.7. and Fig.8.) can then be saved with the .pdf extension required for professional printing at the printer. In this saving mode, each card is saved on a new page of the same size and the front pages of cards with the same back are saved in a separate file. If all cards have a purple back, as in the case of the LimStorm

deck, only one file is created for this card type. In addition to all the items marked within that category, an additional page, the back, is added as the last page to the content. The *"Print"* button can be changed to "A4" if necessary. The cards are then printed on a standard size of A4 paper, 210 mm x 297 mm, laid out in five columns and two rows with minimum space for space-saving printing at home.

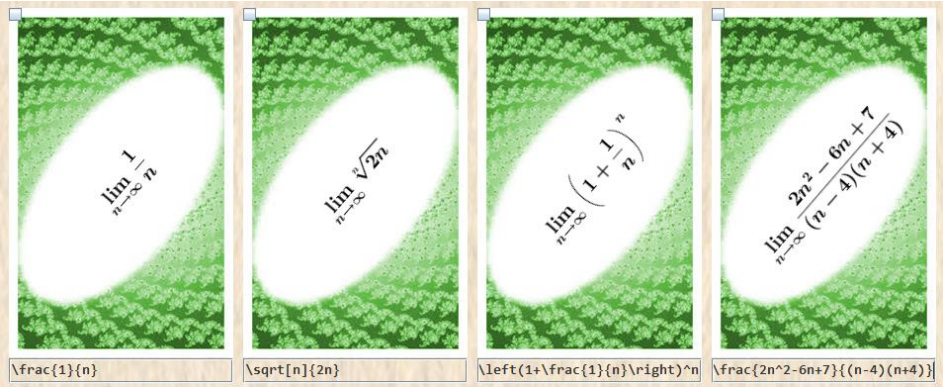

Fig. 7. The process of editing cards

For the cards in the red series, this layout is shown in Fig. 7. If at least one card is marked with a tick and then the *Save Marked* option is used, a pop-up window appears on the display. The save component of the application is in English because this window is used as a complex pre-written program code. Its most important feature is that you can scroll down the location selector to specify an arbitrary location for the pdf file, and type in the file name. If the file already exists, the program will ask for an overwrite and if the file has been successfully saved, the application will send a message to the user with the text *"Successful save!"*. To continue working in the software, the save window must be closed.

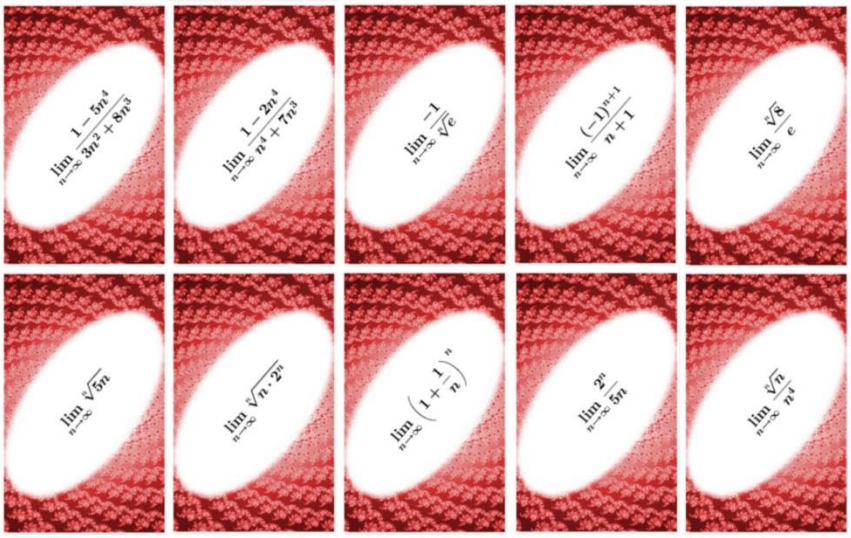

Fig. 8. The red cards of LimStorm

The *Help!* button on the menu bar of the Card Editor window is a helper function, which has been used to collect the most important LaTeX commands for displaying mathematical expressions for users less familiar with LaTeX. The *Help!* window is not resizable, has a vertically movable slider and can be positioned by clicking on its header. Its advantage is that it is always positioned above the *Card Editor* interface, so you can view the help window while editing cards, i.e. writing in the text fields.

Clicking on the *Additional Cards* button in the *main menu* displays the so-called action cards that cannot be edited. There are exactly four cards in a row, regardless of the size of the window (see Fig.9.). The panels differ from the that of the editable cards. Instead of a text input field, you can set the number of cards in the deck. In order to select the number of cards you want to save, you must first select the checkbox of the card you want to save by left-clicking on it. Each card type has a maximum number of cards, which is the quantity needed for the whole deck. This quantity from a given card is indicated by the last number in the drop-down list next

to the *pcs* (pieces) field. We made selecting fewer cards than the maximum possible, so in the case of attrition or damage to existing cards a replacement can be made. A further click on the checkbox resets the number of cards of the given type to the default quantity, zero. The menu bar contains two push buttons and choice button.

Fig. 9. Part of the Additional cards window

Clicking on the *Total Quantity* option will check all eight types of cards and place the maximum quantity in the piece count fields. On the next click, the selections are cleared, and the quantities are set to the default zeroes. To exit the *Additional Cards* menu, the user shall click “X”. The interface will then disappear, and the *Main Menu* will reappear on the screen. Note that the program remembers the settings of the *Additional Cards* window - its position, size, cards and quantities selected and the position of buttons - until you click *Exit* in the *Main Menu*. So, if you choose *Additional Cards* in the *Main Menu* again, you can pick up where you left off.

The LimStorm is made fun and action-packed with using the action cards, which can give you an advantage or put you at a disadvantage. Action cards (see Fig.10.) can be played when the player deems it necessary and only one of this type of card can be played at a time, i.e. no two cards of the same type can be played at the same time. Action cards are rainbow-colored, so once they have been played, if the instruction on them has been validated, the next player may continue the game by discarding a card of any color.

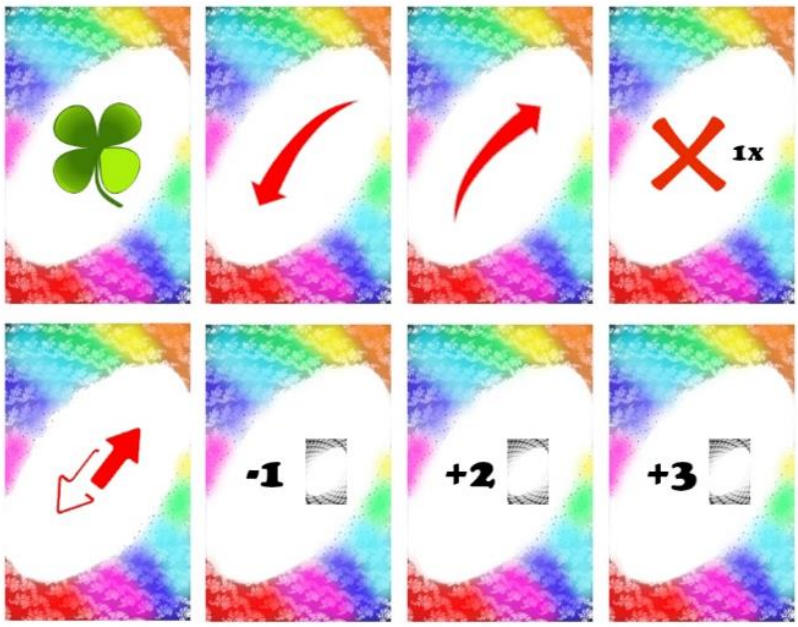

Fig. 10. Action cards of the LimStorm deck

5. Conclusions

The LimStorm game was developed specifically for small group of learners. We consider it feasible to use in practical and consultation classes, adapted to the training structure. In the lectures on the topic of the sequences, the theoretical foundations are laid, followed by the solution of the tasks related to the topic in the practical lessons. Here, the didactic tool LimStorm can be used. In order to create a deck of cards of sufficient quality, it was necessary to have a card editing application. We could not find a program available online that could do the job, so we started to build our own application. We collected the requirements that we had for the card generating application during the creation of the test deck and implemented the program in the widely used object-oriented language Java, in Eclipse development environment. We made sure that the program was transparent, easy to use and had clear functions. During the development work we used the external libraries jlatexmath-1.0.7 and itextpdf-5.5.13. The former package was used to interpret LaTeX commands, the latter to perform operations on the pdf file. The LaTeX editor was integrated into the software to provide card decks that would display mathematical formulas in a sophisticated way, to allow easy modification of the originally designed deck and the creation of additional cards or even a completely new deck of cards in the future. The basic cards in the program can be edited, but not the action cards, since there is no reason to edit the latter. The development of the application was a time-consuming task, but we thought it was worthwhile to create a program that would allow the creation of as many card decks as you like. A key issue for didactic games is to ensure that differentiation is possible. In a card game this requirement is met if you can easily create a new deck or extra cards at any time. The card editing application offers a solution to this. A full LimStorm deck is shown in Fig. 11. For the user testing, we ordered three decks from the printer, so we can currently play with a maximum of 30 students. We are also planning to purchase additional decks to support home learning, and work has started on an online version of the LimStorm game.

Fig. 11. The full deck of the LimStorm

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