Pythagoras

2021-1-RO01-KA220-HED-000032258

FIRST YEAR WEBINAR

Day 2: *Monday 23rd 2023*

IO3 (WP3) Design and Developing the Formative Assessment Software - integration of STACK into LMS (KAU + LBUS)

Co-funded by the Erasmus+ Programme of the European Union

Results and outcomes

Project intellectual outputs:

IO1. Toolbox for teachers on Education for Sustainable Development (ESD);

IO2. Learning scenarios and guide for gamifying online and hybrid mathematics education at university level;

IO3. An online and open access pre-Calculus and Calculus course (MOOC) in English;

Project activities:

(1) Train the Trainers how to teach ICT tools & Learning analytics for students at risk (summer school for trainers);

(2) Teaching & learning mathematics (summer school for students).

Intellectual output 3

IO3 - An online and open access pre-Calculus and Calculus (MOOC)

Leading Organizations:

Karlstad University Sweden & Lucian Blaga University Sibiu (KAU + LBUS)

KAU will closely collaborate with LBUS in the realization of the output. ***All the other partners are helping*** towards identifying the requirements for selecting successful initiatives.

Start date: 11.01.2023; End date: 01.11.2024

Project Results Details (3)

Result ID	3
Result Title	An online and open access Precalculus Course (MOOC) in English
Result Leading Organisation	KARLSTADS UNIVERSITET (E10208923 - Sweden)
Result Description (including: needs analysis, target groups, elements of innovation, expected impact and transferability potential)	Construction of an online package of tasks with automatic feedback for Precalculus and Calculus 1 courses. The focus of the tasks is on the fundamentals of Calculus (Functions, Differential Calculus in one variable and Applications of derivatives).In the construction of the tasks we use a combination of a dynamic mathematics software (DMS) and a computer-aided assessment (CAA) system. The focus is on the design of tasks and automated feedback of high quality so as to students' engagement and conceptual understanding in mathematics. The tasks are implemented in the CAA STACK and some of them use for visualization the DMS GeoGebra. Both STACK and GeoGebra are free of charge. STACK is accessible by MOODLE. (Responsible Partner: KAU & LBUS) Background It is well established that the transition from secondary school mathematics to university mathematics is challenging for many students. Besides the wide variety in background, interest and prerequisite knowledge among students (Rønning, 2017), many students enter mathematics courses in higher education with insufficient basic mathematical skills (Abdulwahed et al., 2012; Vasko et al., 2018). This, in turn, leads to unsuccessful study results for many students, which might cause problems, not only in subsequent mathematical courses, but within other applied subjects, e.g. mechanics and electronics, as well (Harris et al., 2015). To tackle the 'transition problem', many educators in higher mathematics education have introduced continuing assignments to increase students' engagement early during a course, and prevent students from waiting to work on course material until shortly before the final exam (Rønning, 2017; Vasko et al., 2018). To ensure that students give time to these frequent assignments, they are (most often) graded and constitute part of the course examination. This in turn, requires major effort from the teacher in terms of correction work (Rønning, 2017). However, the past decade has seen the rapid development of technology that supports teachers in the time-consuming correction work by offering automated correction of student responses. A common notion for these types of technology is computer-aided assessment (CAA) systems. Today, many first year mathematics courses in higher education utilize mathematically sophisticated CAA systems, such as STACK and Möbius (e.g. Rasila et al., 2015; Vasko et al., 2018). However, there still remain important constraints to be reconsidered in future research and development. In discussing future pressures and tensions in this area, Hoogland and Tout (2018) claim that "[i]t will need a significant effort to prevent mathematics education slipping into a highly sophisticated system of automated assessment of

	lower-order skills." (p. 681). So far, CAA systems have mainly been used for assessing basic mathematical procedural skills (e.g. Rasila et al., 2015). It is a challenge to design tasks for a CAA system that address higher-order skills in mathematics, and to design feedback that goes beyond categorizing a final answer as being right or wrong (Rønning, 2017). At the same time, it is well established in the wider literature that feedback has a significant impact on student achievement. The research field on feedback in educational contexts is large and there are many well-cited review papers published (e.g. Hattie & Timperley, 2007; Mory, 2004; Shute, 2008) which highlight the complexity of the feedback construct and that the effect of feedback depends on many distinct variables. Shute (2008) uses the notion of 'formative feedback' and defines it "...as information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning."(p. 154). Yet another possibility to increase the learning potential when using a CAA system is to embed another type of technology: dynamic mathematics software (DMS) (Rasila et al., 2015; Sangwin, 2013). This type of technology is widely recognize
Result Type	Methodologies / guidelines – Evaluation method and tool
Please describe the division of work, the tasks leading to the production of the result and the applied methodology	KAU is going to be responsible for the design of the tasks and the formative feedback for the tasks. KAU is going to use the experience from their previous projects concerning design of tasks as well as the results from the pilot conducted in the fall 2020 for around 300 engineering students at Karlstad University. The details are given above. LBUS is going to be responsible for implementing the tasks in STACK, process that supposes a considerable part of programming. The implemantation is going to be in STACK, a free of charge platform available via MOODLE. To be able to deliver a package of high quality tasks, we need, in the design process, to test the tasks on university teachers and students. For this we plan the following actions. Train the Trainers on how to use the online task package - one online webinar with both lectures and workshops (Responsible Partner: KAU & LBUS) Test the task package: Two schools are planned in Porto and in Chania as face to face events. Students are going to work intensively with the task packages. (Responsible Partner: KAU & LBUS) Evaluation of the tasks: through questionnaires and interviews on both teachers and students. (Responsible Partner: KAU) Improvement of the task package: based on the evaluation results (Responsible Partner: KAU & LBUS)
Result Production Start Date (dd-mm-yyyy)	11-11-2022
Result Production End Date (dd-mm-yyyy)	01-11-2024
Result Languages	English
Result Media	Software

Content of IO3

- Construction of an ***online package of tasks with automatic formative feedback*** for pre-Calculus and Calculus courses. The focus of the tasks is on the fundamentals of Calculus (functions, differential Calculus in one variable and applications of derivatives).

- In the construction of the tasks we use a ***combination of a dynamic mathematics software (DMS) and a computer-aided assessment (CAA) system***. The focus is on the design of tasks with automated formative feedback of high quality so as to students' engagement and conceptual understanding in mathematics.

- The tasks are implemented in the ***CAA STACK*** and some of them use for visualization the ***DMS GeoGebra***. Both STACK and GeoGebra are free of charge. STACK is accessible via MOODLE.

Organization of IO3

- KAU is going to be responsible for the design of the tasks and of the formative feedback for the tasks. KAU is going to use the experience from their previous projects concerning design of tasks as well as the results from the pilots conducted in 2020-2022 for around 750 engineering students at Karlstad University.
- LBUS is going to be responsible for implementing the tasks in STACK, process that supposes a considerable part of programming. The implementation is going to be in STACK, a free of charge platform available via MOODLE.
- To be able to deliver a package of high quality tasks, we need, in the design process, to test the tasks on university teachers and students. For this we plan the following actions.

    Train the Trainers on how to use the online task package - one online webinar with both lectures and workshops (Responsible Partner: KAU & LBUS)

    Test the task package: Two schools are planned in Porto and in Tenerife as face to face events. Students are going to work intensively with the task packages. (Responsible Partner: KAU & LBUS)

- Evaluation of the tasks: through questionnaires and interviews on both teachers and students. (Responsible Partner: KAU)
- Improvement of the task package: based on the evaluation results (Responsible Partner: KAU & LBUS)

Background of IO3

- It is well established that the ***transition from secondary school mathematics to university mathematics*** is challenging for many students.

- Besides the wide variety in background, interest and prerequisite knowledge among students (Rønning, 2017), many students enter mathematics courses in higher education with insufficient basic mathematical skills (Abdulwahed et al., 2012; Vasko et al., 2018).

- This, in turn, leads to unsuccessful study results for many students, which might cause problems, not only in subsequent mathematical courses, but within other applied subjects, e.g. mechanics and electronics, as well (Harris et al., 2015).

Background of IO3

- To tackle the ‘transition problem’, many educators in higher mathematics education have introduced ***continuing assignments*** to increase students’ engagement early during a course, and prevent students from waiting to work on course material until shortly before the final exam (Rønning, 2017; Vasko et al., 2018).
- To ensure that students give time to these frequent assignments, they are (most often) graded and constitute part of the course examination. This in turn, requires major effort from the teacher in terms of correction work (Rønning, 2017).
- However, the past decade has seen the rapid development of technology that supports teachers in the time-consuming correction work by offering ***automated correction*** of student responses. A common notion for these types of technology is ***computer-aided assessment (CAA) systems***. Today, many first year mathematics courses in higher education utilize mathematically sophisticated CAA systems, such as **STACK** and **Möbius** (e.g. Rasila et al., 2015; Vasko et al., 2018).

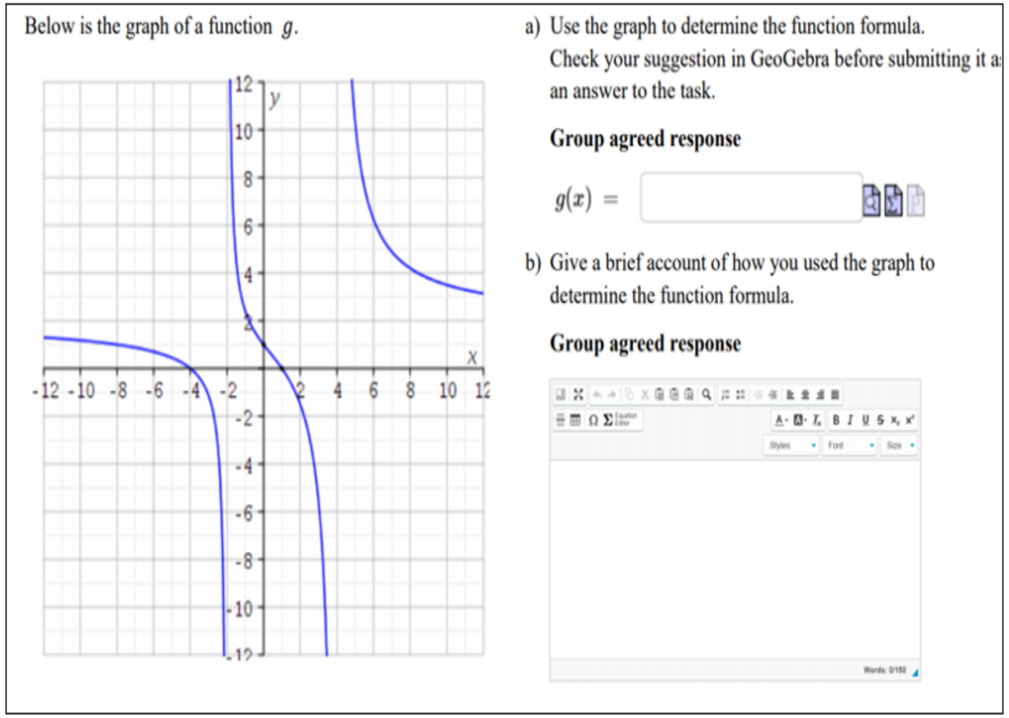
Background of IO3

- So far, CAA systems have mainly been used for assessing basic mathematical procedural skills (e.g. Rasila et al., 2015). ***It is a challenge to design tasks for a CAA system that address higher-order skills in mathematics, and to design feedback that goes beyond categorizing a final answer as being right or wrong*** (Rønning, 2017).
- At the same time, it is well established in the wider literature that feedback has a significant impact on student achievement. Shute (2008) uses the notion of '***formative feedback***' and defines it "…as ***information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning***."(p. 154).
- Yet another possibility to increase the learning potential ***when using a CAA system is to embed another type of technology: dynamic mathematics software (DMS)*** (Rasila et al., 2015; Sangwin, 2013). This type of technology is widely recognize.

Type of tasks with formative feedback

- **Translation task**:

From graph to formula



Possible feedback

Instead of asking for an explanation, ask students to declare what they used by choosing among various suggested options.

- The zeros
- The vertical asymptotes
- The horizontal asymptotes
- One more point that is not a zero
- Three points that are not zeros
- GeoGebra

Depending on their response, they will receive different elaborated feedback.

For example, if they not have used the horizontal asymptote, they will be asked to solve a new task in which they are (explicitly) asked to utilize the horizontal asymptote.

Type of tasks with formative feedback

- **Example-generating task**:

Give examples of two different functions, f and g, both of which have

- two vertical asymptotes, $x = -6$ and $x = 3$, as well as
- a horizontal asymptote, $y = 2$.

Note:

- Group members may have received different asymptotes.
- Check in GeoGebra if your suggested functions really have the given asymptotes.

Individual response:

$f(x) =$

$g(x) =$

Possible feedback

Since we think that it is instructive for students to realize that there are various ways of thinking that results in different types of formula, it would have been great if the CAA system could recognize the type of formula used by a student.

So, for example, if a student uses a formula of the following type: $f(x) = \frac{ax+b}{(x+6)(x-3)} + 2$ (in both examples), the elaborated feedback could be something like:

"Great, the answers are correct. However, another correct answer could be: $f(x) = \frac{2x^2}{(x+6)(x-3)}$.

How do you think a student who came up with this answer has been reasoning? Now, use this strategy to provide an example of a function with the following asymptotes…"

Type of tasks with formative feedback

- **Step-by-step interactive task** - guiding the learner in the resolution of a task after one or more autonomous attempts

- The feedback begins immediately after answering one question, when students are working on an online test. After showing the correctness of the answer, the system proposes a step-by-step resolution that interactively shows a possible process for solving the task.

- This interactive feedback can be displayed only to the students who failed to answer autonomously to the main question, or even to those who made it correct. Its function can be guiding students in the argumentation of the solving process or comparing their solving strategy with a correct one.

- In the interactive feedback, sub-questions investigate prerequisites, simpler tasks, or other representations of the initial problem, to guide students to a possible way to tackle the task. At each step, if they give the wrong answer, the correct one is shown to be used in the following steps.

(Barana et al (2021) "Interactive Feedback for Learning Mathematics in a Digital Learning Environment")

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Let's see some examples in **STACK**!