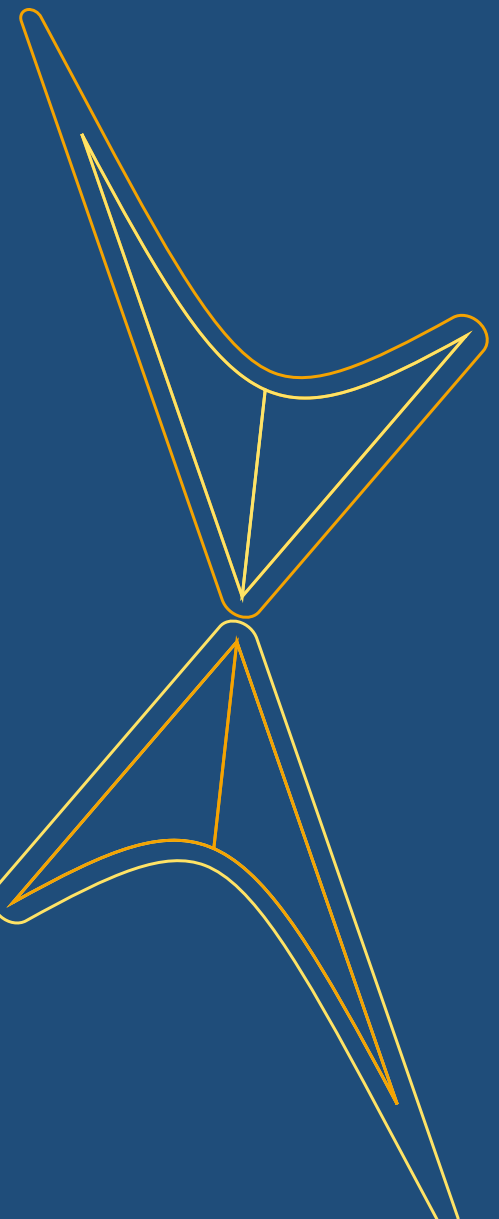

The ASYMPTOTE System

Long-Term Curriculum

Structure

The ASYMPTOTE Long-Term Curriculum was built in four modules, which are listed below:

Module	Chapter
Theoretical Background	Teaching and learning with ASYMPTOTE in the continuum from face to face to online education
	Online Pedagogy Theoretical Frameworks
	Teaching and Learning Design for ASYMPTOTE
	Introduction to ASYMPTOTE
The ASYMPTOTE App	
The ASYMPTOTE Web Portal	
The Digital Classroom	

The following slides were designed by the ASYMPTOTE consortium for university courses. They were used for courses at Goethe University Frankfurt (Germany), University of Bielefeld (Germany), University of Catania (Italy) and University of the Aegean (Greece).

The slides are offered to enable all interested lecturers to transfer the course to their universities. Please feel free to use them!

For any questions, please contact info@asymptote-project.eu

Structure

The ASYMPTOTE Long-Term Curriculum was built in four modules, which are listed below:

Module	Chapter	Section	Slide
Theoretical Background	Teaching and learning with ASYMPTOTE in the continuum from face to face to online education	1.1 Introducing ASYMPTOTE	6
		1.2 The Continuum of Educational Settings	14
		1.3 Teacher Roles	32
		1.4 Teacher Standards	37
		1.5 Use of ASYMPTOTE in Various Settings	45
	Online Pedagogy Theoretical Frameworks	2.1 Community of Inquiry	54
		2.2 E-Moderation & E-Tivities	70
		2.3 Mobile Learning Pedagogies	88

Structure

The ASYMPTOTE Long-Term Curriculum was built in four modules, which are listed below:

Module	Chapter	Section	Slide
Theoretical Background	Teaching and Learning Design for ASYMPTOTE	3.1 Teaching as a Design Science	98
		3.2 Pedagogical Scenarios: Learning Scripts	104
		3.3 General Pedagogical Patterns	108
		3.4 Online Teaching Strategies	117
		3.5 Task Design in ASYMPTOTE	131
	Introduction to ASYMPTOTE	4.1 The ASYMPTOTE Idea	149
		4.2 Key Functionalities of ASYMPTOTE	158

Structure

The ASYMPTOTE Long-Term Curriculum was built in four modules, which are listed below:

Module	Section	Slide
The ASYMPTOTE App	5. How to Use the ASYMPTOTE App	163
The ASYMPTOTE Web Portal	6.1 Registration	190
	6.2 Selection of Tasks	193
	6.3 Selection of Learning Graphs	204
	6.4 Sharing & Publication of Contents	216
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	6.6 Task Formats	239
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The Digital Classroom		268
Supporting Material		294

Teaching and learning with ASYMPTOTE in the continuum from face to face to online education

1.1 Introducing ASYMPTOTE

Teaching during Covid-19 Pandemic

Corona pandemic led to Emergence Remote Teaching (ERT) in Spring 2020, i.e., “is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances” (Hodges et al. 2020)

Role of teachers:

- maintaining the educational process (Hodges et al. 2020) & developing the “new normal” (Sehoole, 2020)
- finding solutions to overcome rising problems (Aldon et al., 2021)
- rearranging & adopting classroom practice, mostly by the help of digital media & the internet (Crompton et al., 2021)
- developing remote, synchronous and asynchronous forms of teaching (Mishra et al., 2020; Zhang et al., 2020)

Learning during Covid-19 Pandemic

Corona pandemic led to Emergence Remote Teaching (ERT) in Spring 2020, i.e., “is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances” (Hodges et al. 2020)

Role of students:

- lack of personal contact & feedback (Aldon et al., 2021; Giovanella et al., 2020; Jimoyiannis et al., 2020)
- high degree of students’ self-organization and self-management (Agostinelli et al., 2020)
- lack of adequate technical equipment & media competencies (Barlovits et al., 2021)
- increase of learning gaps and inequality (Agostinelli et al., 2020)

The ASYMPTOTE Project

Issues occurred during Covid-19-induced distance education led to the development of "ASYMPTOTE":

Adaptive
Synchronous
Mathematics
learning **P**a**T**hs [resp. graphs]
for **O**nline **T**eaching
in **E**urope"

Adaptive

- Guided learning environment
- Task allocation
- Hints
- Systemic feedback

Synchronous

- Learning at a common time
- Teamwork with classmates & individualized feedback via chat
- Monitoring function for teachers

Mobile

- Learning by using smartphones or tablets
- Low participatory learning barriers

The ASYMPTOTE Project

ASYMPTOTE is developed as a two-component system:

Web portal

- Working space for teachers
- Creation of tasks & learning paths/graphs
- Open database of tasks & learning paths/graphs
- Monitoring of students' working progress via the Digital Classroom feature

App

- Working space for students
- Display of task formulation, stepped hints & sample solution
- Direct systemic feedback & gamification
- Guided learning environment
- Teacher-student & student-student interaction via chat

The ASYMPTOTE Project

ASYMPTOTE's features can be utilized in various teaching and learning settings:

From face to face to blended and online learning, ASYMPTOTE can be an asset for both teachers and students. Thus, ASYMPTOTE can be placed in the concepts of Technology Enhanced Learning.

DEFINITION

Technology Enhanced Learning – TEL, in the current context, is used to describe the applications of technology in education that aim at improving the processes of teaching and learning.

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Teaching and learning with ASYMPTOTE in the continuum from face to face to online education

1.2 The continuum of educational settings

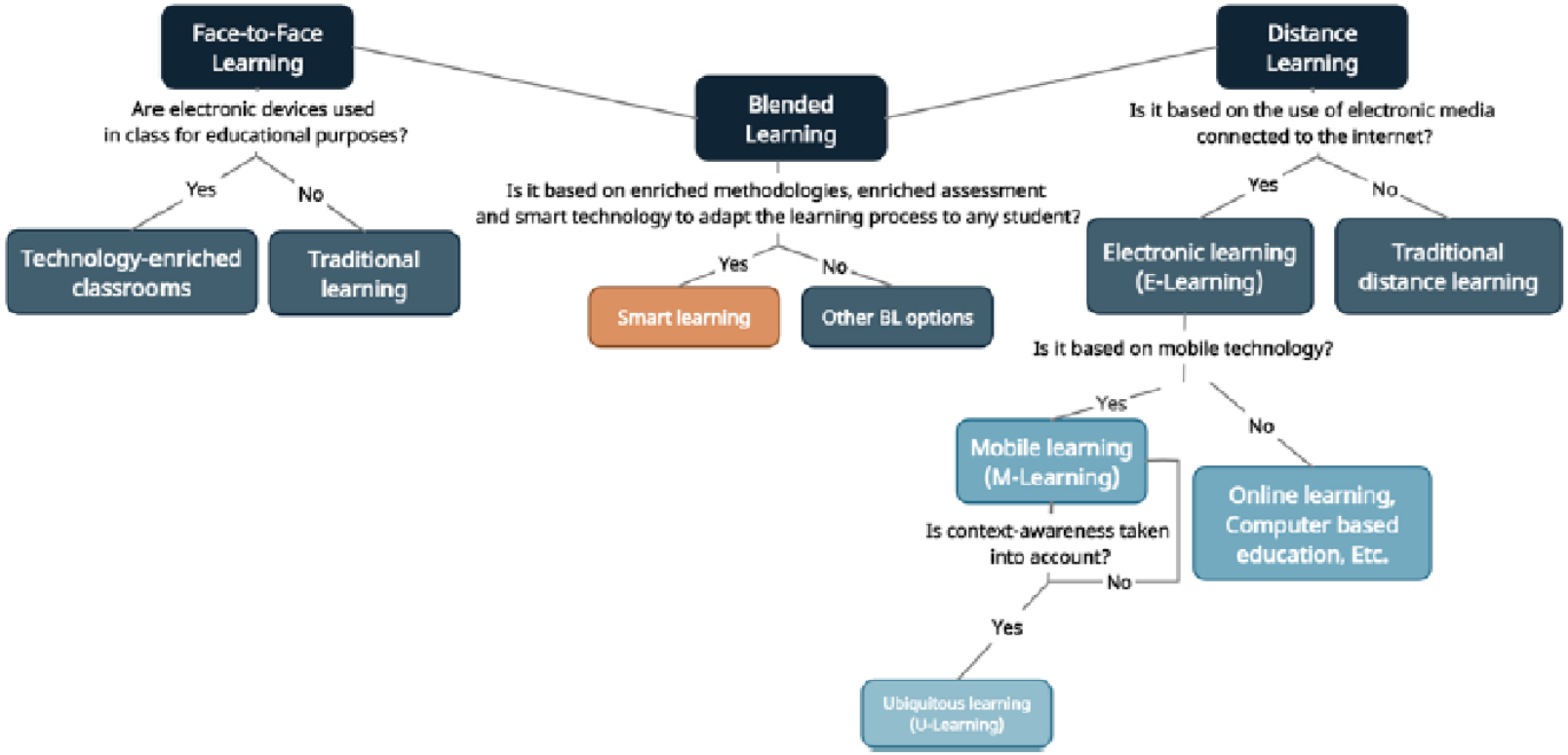
Technology Enhanced Learning

DEFINITION

Technology Enhanced Learning – TEL, in the current context, is used to describe the applications of technology in education that aim at improving the processes of teaching and learning.

- Technology is used in all education processes to enhance teaching and learning (Cakir et al., 2009)
- The different uses of technology in education result in a wide range of pedagogical possibilities (Redmond, 2015)
- Three key concepts of TEL are face-to-face, blended & distance learning (García-Tudela et al., 2021)

Key concepts of Technology Enhanced Learning according to García-Tudela et al. (2021)

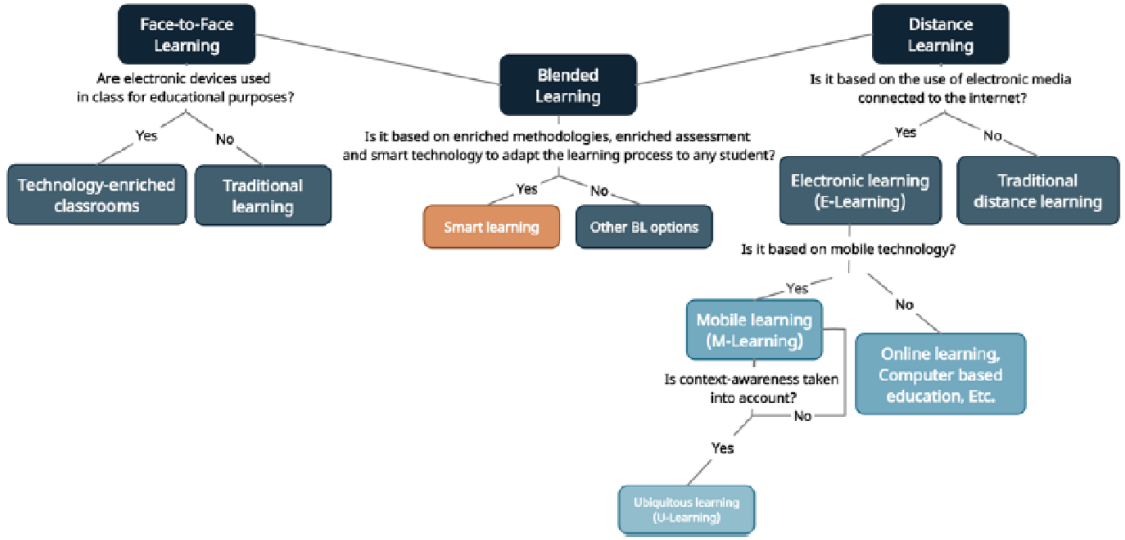


Technology Enhanced Learning

Key concepts of Technology Enhanced Learning according to García-Tudela et al. (2021)

Degree of use of technology:

- enrichment of face-to-face learning in the traditional classroom
- combination of traditional and online processes with a mixed approach (blended model)
- delivering education exclusively online in synchronous and asynchronous forms

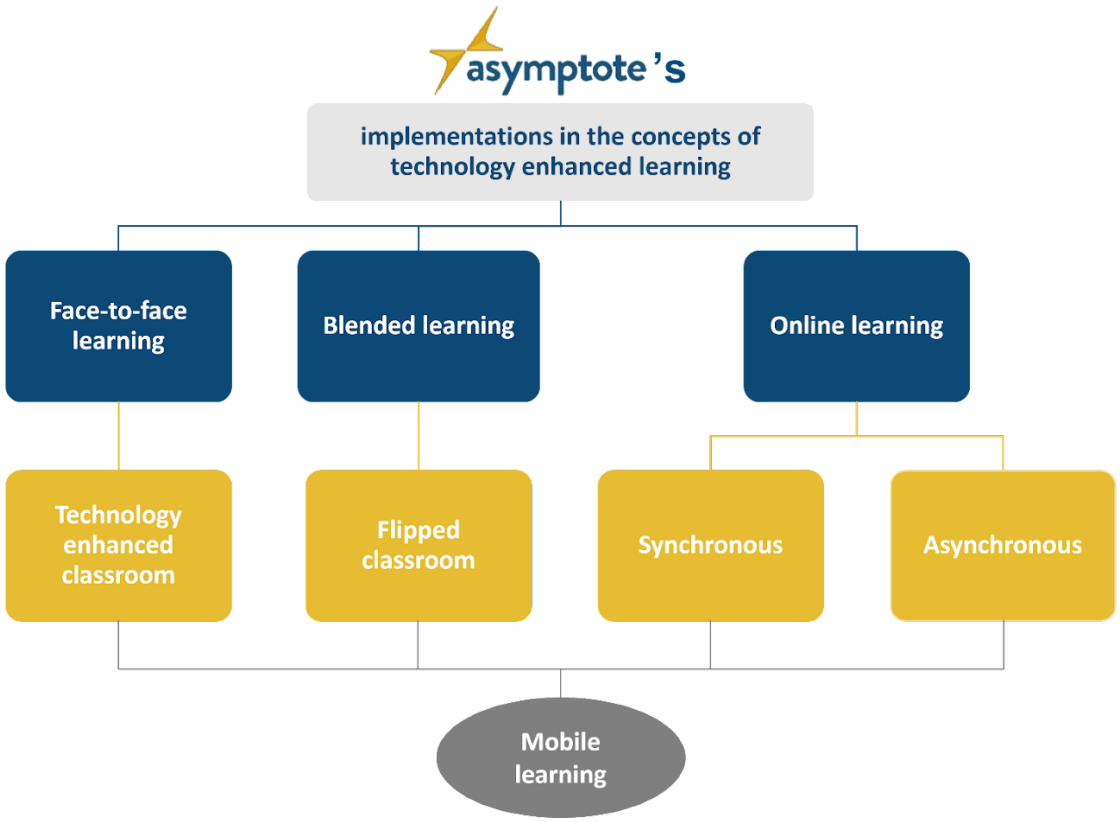


Technology Enhanced Learning with ASYMPTOTE

The ASYMPTOTE system can enhance learning these three key concepts of TEL

Possibilities to use the ASYMPTOTE system:

- enrichment of face-to-face learning in the traditional classroom
- combination of traditional and online processes with a mixed approach (blended model)
- delivering education exclusively online in synchronous and asynchronous forms



A. Face to face Technology Enhanced Learning

Enrichment of the traditional classroom: face-to-face learning is supported by digital tools, such as assessment tools, task delivery systems, inquiry instruments, mindtools to construct knowledge etc.

Characteristics of a face-to-face technology enhanced classroom (Roblyer, 2006):

- All the meetings occur face to face
- The use of digital tools aims to enrich and leverage the education process
- Educational material is a mix of traditional and digital, and can be provided through the world wide web
- Online communication and support are possible
- Tasks and activities can be implemented online

Example (Redmond, 2015):

- teacher's website/blog to provide information discussed in class

A. Face to face Technology Enhanced Learning

Enrichment of the traditional classroom: face-to-face learning is supported by digital tools, such as assessment tools, task delivery systems, inquiry instruments, mindtools to construct knowledge etc.

ACTIVITY

Design your own face to face Technology Enhanced Learning instruction for a specific mathematics topic. In what way can Asymptote's features (see page 3-4) foster the chosen instructional design?

B. Blended learning

Blended learning: combination of traditional and online processes, i.e., curriculum, teaching materials, and assessment methods are developed and implemented online and face to face (Delialioglu & Yildirim, 2007)

Characteristics of a blended learning (Delialioglu & Yildirim, 2007):

- Recurring meetings in person
- Online communication and support are important
- Learning material are provided online
- Activities and assignments are conducted off and online
- 30% to 79% of the course is provided online (Allen & Seaman, 2013)

Sub-model:

- Flipped Classroom

B. Blended learning – Flipped Classroom

Flipped Classroom (FC): sub-model of blended learning which transfers the centre of the teaching-learning relationship from the educator to the students

The core idea of FC (Bergmann & Sams, 2012; EDUCAUSE, 2012; Estes et al., 2014; Tucker, 2014):

- Educator-centred part of teaching is available at home
- In class session, space and time is used for activating learning methods

DEFINITION

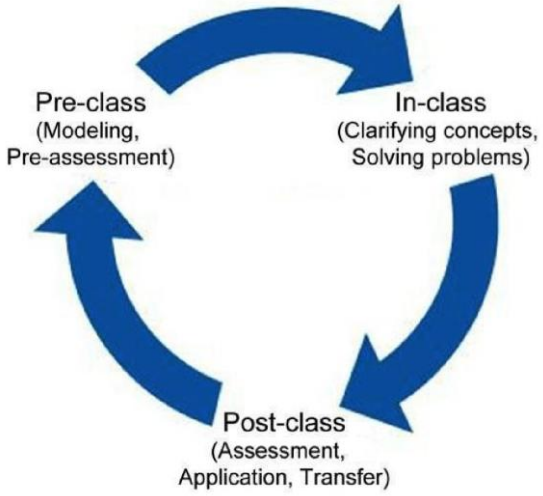
Bishop and Verleger (2013, p.5) define Flipped Classroom as *"an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom".*

B. Blended learning – Flipped Classroom

Flipped Classroom (FC): sub-model of blended learning which transfers the centre of the teaching-learning relationship from the educator to the students

A model of FC (Estes et al., 2014):

- Pre-class: instructional and assessment material, e.g., video-lectures, online exercises or quizzes, and online support (hints, discussion, comments, messages etc.).
- In-class: activities with interaction and collaboration for exploring topics in depth and clarifying misunderstandings
- Post-class: activities to assess, apply or transfer various learning contexts



B. Blended learning – Flipped Classroom

Flipped Classroom (FC): sub-model of blended learning which transfers the centre of the teaching-learning relationship from the educator to the students

ACTIVITY

Design your own FC model for a specific mathematics topic. In what way can Asymptote's features (see page 3-4) foster each stage of the circular continuous format described above (see Figure 1.3)?

C. Online learning

Online learning: education is delivered exclusively online in a synchronous or asynchronous way, including digital learning materials, online communication and interactivity as well as access tracking (Nichols, 2003)

Characteristics of online learning (Allen & Seaman, 2013):

- The instructions are solely online
- Communication and support occur only remotely though the internet (synchronously and/or asynchronously)
- Learning material, activities, assignments, and assessment are provided exclusively online
- Digital tools are the main instrument of the instruction

C. Online learning – Synchronous and asynchronous instruction

Online learning: education is delivered exclusively online in a synchronous or asynchronous way, including digital learning materials, online communication and interactivity as well as access tracking (Nichols, 2003)

Synchronous

- Learning at a common time
- Mostly arranged via videoconferencing
- Teaching methods similar to face-to-face settings
- key elements to success:
  - Collaboration & support
  - Socialization & informal exchange

Asynchronous

- Learning at a flexible time
- Mostly arranged via Learning Management System
- Participants follow a personal program in their individual pace
- key elements to success:
  - Self-organization of students
  - self-education and self-construction of knowledge

(Conrad & Donaldson, 2004; Finkelstein, 2006; Nichols, 2003; Papachristos et al., 2010)

C. Online learning – Synchronous and asynchronous instruction

Online learning: education is delivered exclusively online in a synchronous or asynchronous way, including digital learning materials, online communication and interactivity as well as access tracking (Nichols, 2003)

ACTIVITY

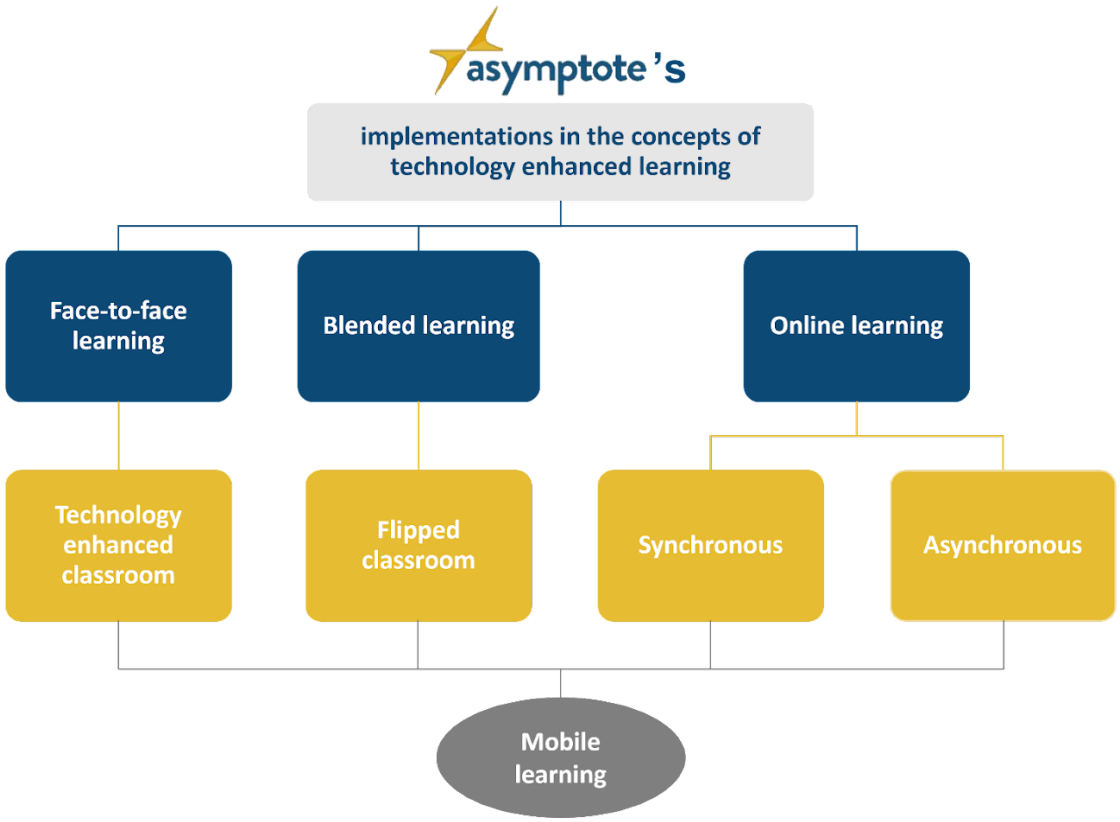
Design an online instruction with synchronous and asynchronous aspects for a specific mathematics topic. In what way can Asymptote's features (see page 3-4) foster the chosen instructional design? Where could you find or how could you develop your own tutorial material?

Technology Enhanced Learning with ASYMPTOTE

The ASYMPTOTE system can enhance learning these three key concepts of TEL using a mobile learning approach

Possibilities to use the ASYMPTOTE system:

- enrichment of face-to-face learning in the traditional classroom
- combination of traditional and online processes with a mixed approach (blended model)
- delivering education exclusively online in synchronous and asynchronous forms



Mobile learning

Mobile learning: use of mobile devices, such as smartphones or tablets, for education due to their portability and possibilities for communication and interactive representations (Kearney et al. 2020)

DEFINITION

According to Yamamoto (2013, p.16) *"Mobile learning is a technological infrastructure that removes the barriers on accessing information in learning (e.g., teachers, time, space, and resources), it is an interactive method of learning which offers personal, social and contextual learning opportunities, which can be offered anywhere without breaking apart from life. These opportunities", Yamamoto adds, "are offered in real/virtual environments with various mobile instruments that can provide learning material and enriched multimedia, while placing the student in the centre of the learning process".*

Mobile learning

Mobile learning: use of mobile devices, such as smartphones or tablets, for education due to their portability and possibilities for communication and interactive representations (Kearney et al., 2020)

Perspectives on mobile learning as an educational process (Winters, 2007)

- Technocentric: learning using a mobile device.
- Relationship to online learning: mobile devices as flexible delivery medium
- Enhancing traditional education: mobile learning as tool for enriching formal education
- Learner-centred: mobility of the learner

By following these perspectives, mobile learning can be linked and applied to each of the three technology enhanced concepts, i.e., face-to-face, blended & online learning.

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Teaching and learning with ASYMPTOTE in the continuum from face to face to online education

1.3 Teacher roles

Technology Enhanced Learning

DEFINITION

Technology Enhanced Learning – TEL, in the current context, is used to describe the applications of technology in education that aim at improving the processes of teaching and learning.

- Technology is used in all education processes to enhance teaching and learning (Cakir et al., 2009)
- The different uses of technology in education result in a wide range of pedagogical possibilities (Redmond, 2015)
- Three key concepts of TEL are face-to-face, blended & distance learning (García-Tudela et al., 2021)

Teacher roles

Role shift: Since TEL effects both, the way of learning and teaching, it also can result in a role shift for the teacher (Redmond, 2015).

Teacher roles in online environments resp. in TEL settings:

Berge (1995) Four roles per teacher	Palloff & Pratt (2003) Four role characteristics	Serdyukov (2015) One role per teacher
• Pedagogical: e.g., providing feedback, encouraging participation & questioning • Social: creating a “cohesive learning community” • Managerial: organizational, procedural & administrative tasks • Technical: “make the technology transparent“ to the students	• flexibility • collaboration • ability to learn from others • ability to share control with the participants	• Leaders: Actively leading & guiding student’s learning process • Facilitators: Passive role of the teacher, reacting to questions and proving support if needed • Mediators: Balanced & desired role; engaging and interacting without direct management
Teaching as manifold challenge	**Value of personal contact**	**Personality of the teacher**

Ecoshock

Teacher role: Shift to TEL settings requires a new pedagogical and methodological considerations

Student role: Shift to TEL settings leads to the loss of familiar structures which can result in an **ecoshock**, i.e., the physiological and psychological reaction to a new, diverse, or changed ecology affecting the quality of experience, performance and motivation (Fontaine, 2000; San Jose, & Kelleher, 2009)

In Covid-19-induced distance education, this loss of familiar structures was reported as major issue (Barlovits et al., 2021)

Thus, **digital competencies** are required for TEL settings and in particular online learning, on teacher's and student's side.

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Teaching and learning with ASYMPTOTE in the continuum from face to face to online education

1.4 Teacher standards

Teacher standards

DEFINITION

Standards for online teaching, refer to the roles, characteristics, competencies, and skills required for a competent and successful online teacher (Albrahim, F. A., 2020)

- Competencies for online teaching have been categorized at different levels in the literature, and several approaches have been adopted to classify them.
- Albrahim, F. A. (2020), have received a focus in a larger number of studies in the literature and developed the following standards.

Teacher Standards

Teacher Standards	The online teacher …
Pedagogical skills	• supports learning and facilitates presence with digital pedagogy. • knows, understands, and applies the value of active learning, participation, and collaboration within the online classroom. • motivates students and shows enthusiasm and interest • personalizes the learning process. • understands how students learn and develop, and provides opportunities that support their intellectual, social, and personal development. • ensures that course material is accessible to student with disabilities.
Design Skills	• understands central concepts, tools of inquiry and structures. • creates learning experiences. • curates and creates instructional materials, tools, strategies, and resources to engage all learners and enable student success. • plans and teaches well-structured lessons.

Teacher Standards

Teacher Standards	The online teacher …
Content Skills	• demonstrates good subject and curriculum knowledge. • is able to link the subject and content with scientific, social, cultural, and any other relevant phenomena. • develops a course outline that includes all course components and elements. • develops and delivers assessments, projects, and assignments. • plans and prepares learning plans based upon knowledge of subject matter, students, the community, and curriculum goals. • understands, uses, and interprets formal and informal assessment strategies to evaluate and advance student performance and to determine program effectiveness.

Teacher Standards

Teacher Standards	The online teacher …
Social and Communication Skills	• uses sufficient and commonly understandable language, requests information and asks questions clearly. • uses a variety of communication techniques. • interacts in a professional, effective manner to support students' success. • creates and develops respectful relationships and a sense of community • personalizes messages and feedback. • facilitates and maintains interactive discussion and information exchange.

Teacher Standards

Teacher Standards	The online teacher …
Management and Institutional Skills	• meets the professional teaching standards. • is a reflective practitioner and is continuously engaged in purposeful mastery of the art and science of online teaching. • knows, understands, facilitates, complies, and encourages legal, ethical, and safe technology use, and copyright issues and standards. • provides online leadership, management, mentoring, and coaching • is able to manage the course time and apply time-saving techniques. • establishes and declares clear rules and regulations for participation, submission of assignments, timeliness, sending and seeking feedback, and communication protocols. • is tracking the course and students' progress on a regular basis.

Teacher Standards

ACTIVITY

Using the form included in the Appendix A. Online Teaching Skills Checklist (Activity 1.4), rate your online teaching skills, and write down the ways that you could improve yourself.

References

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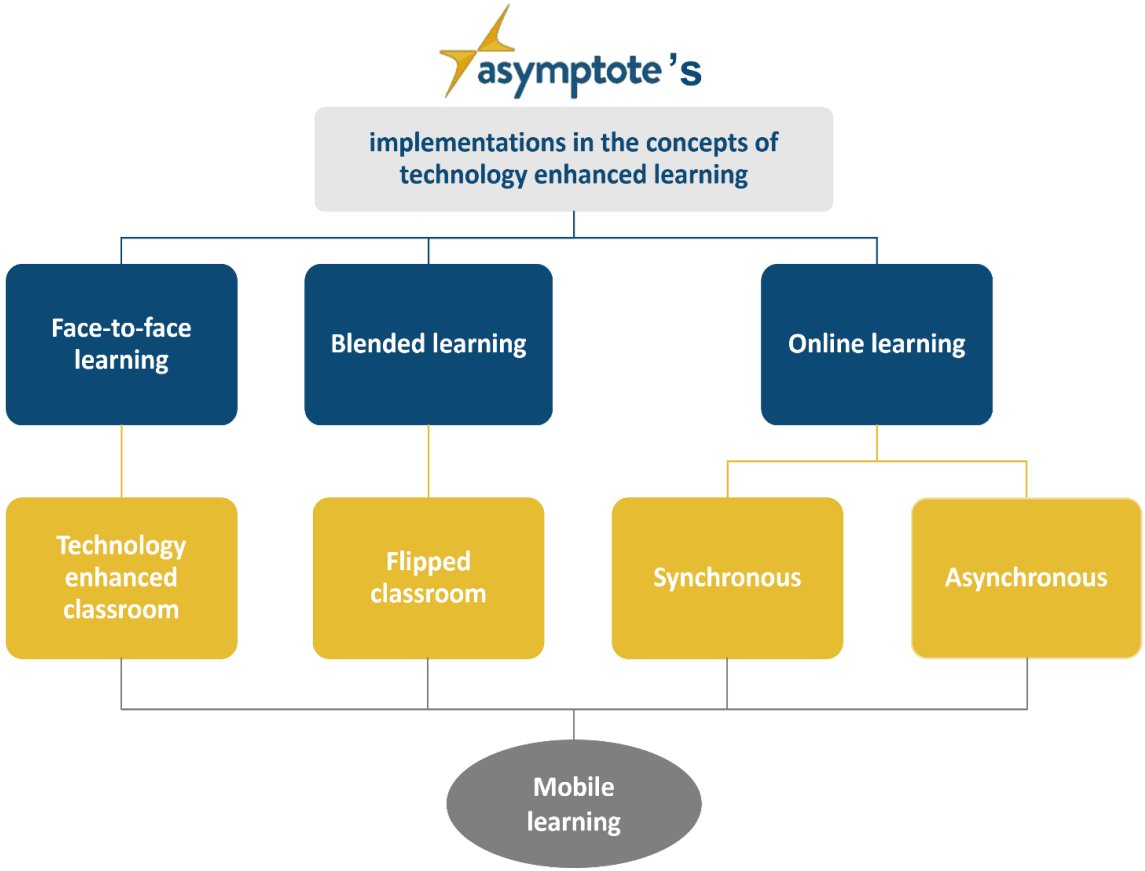
Teaching and learning with ASYMPTOTE in the continuum from face to face to online education

1.5 ASYMPTOTE's uses in the various educational settings

Technology Enhanced Learning with ASYMPTOTE

ASYMPTOTE:

- a tool for secondary and university level Mathematics;
- an App and a Web Portal (repository of tasks, task formulations, hints, and sample solutions);
- its features enable teachers to conduct adaptive online education in Mathematics, while providing evaluation data for the students' progress.



In the spectrum of Technology Enhanced Learning, ASYMPTOTE can be implemented in face to face, blended and online educational concepts.

Face-to-Face Learning:
ASYMPTOTE as a tool for teaching/learning

To help teacher design **learning activities adopted to each student's individual learning** progress, thus reinforcing their learning process:

- **ASYMPTOTE**'s repository of tasks for Mathematics;
- the learning graph designer;
- adaptivity features.

The teacher can choose to incorporate the usage of the app:

- during the time of the teaching;
- at home, as a practice and/or assessment tool.

Blended Learning:
ASYMPTOTE as a tool for teaching/learning and self-learning

- A **traditional learning environment** provides inherent teaching advantages, such as the immediate **feedback** which is essential for any learning environment.
  - **ASYMPTOTE** can offer systematic and immediate feedback on student's entered solutions;
  - **ASYMPTOTE** provides the possibility of concurrent direct communication between the participants and their peers and/or the teacher.
- For the **Flipped classroom model**
  - **ASYMPTOTE** could play a meaningful role both in Pre-class and Post-class stages as a learning activity distribution tool, an assessment instrument and a self-learning tool;
  - **ASYMPTOTE,** through the communication possibilities and the adaptivity features, can also contribute to In-Class stages where data-driven decisions are important to modify and adjust teaching plans based on students' learning performance.

Online Learning:
ASYMPTOTE as tool for online teaching/learning, self-learning and 1-to-1 interaction

ASYMPTOTE can be used:

- as an online teaching and learning tool;
- a self-learning tool;
- as a 1-to-1 interaction tool substituting the practice with teacher support phase of face-to-face teaching.

Through the "**Digital Classroom**" mode the whole learning group can communicate directly bringing some of the in-person aspects of face to face learning to the online process.

Online Learning:
ASYMPTOTE as tool for online teaching/learning, self-learning and 1-to-1 interaction

PROBLEMS **DURING** **COVID-19** **DISTANCE** **LEARNING**

Providing adequate feedback and maintaining personal contact (Barlovits et al., 2021).

SOLUTIONS TO THESE PROBLEMS

- ASYMPTOTE's direct feedback and hints and its communication;
- ASYMPTOTE's hints;
- ASYMPTOTE's communication.

ASYMPTOTE's "Digital Classroom" mode for direct communication between a learners' teacher and their peers can make the communication more immediate and personal, minimising the barriers of online learning. ASYMPTOTE in this case can be used as an interaction tool that stimulates the traditional face-to-face communication.

Interim Conclusion

In the spectrum of Technology Enhanced Learning, ASYMPTOTE can be implemented in face-to-face, blended and online educational concepts.

ACTIVITY

In which of the three Technology Enhanced Learning concepts do you think ASYMPTOTE has the most beneficial role and why?

Summary of ASYMPTOTE's implementations concerning TEL

	Face to face	Blended learning	Online
Space	Teacher and learners interact in the same space – Classroom.	Teacher and learners interact mainly in the same space (e.g. Classroom) but interact online too in virtual spaces (e.g. in >=30% of the interaction a Learning Management System) is used.	Teacher and learners interact mainly (>=80%) or solely online in a virtual space.
Time	Same time synchronous.	Mostly same time - Synchronous and different time – Asynchronous.	Synchronous and Asynchronous.
Communication	Direct and in person.	Both direct/in person and Computer Mediated Communication.	Computer Mediated Communication.
ASYMPTOTE's role	Teaching and learning Technology Enhanced Learning tool. E.g., reinforcing learning, for practice, for assessment etc.	Teaching and learning tool / Self-learning tool.	Online teaching and learning tool. Self-learning tool. 1-1 interaction tool. Immediate Feedback and assessment, chatroom and 1-1 discussions.

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Online Pedagogy Theoretical Frameworks

2.1: Community of Inquiry (CoI)

Introduction

Jacquinot (1993): in the field of distance education

distance can be managed

absence can be eliminated

Today, in the e-learning, the ICTs allow us

manage distance, at least in a spatio-temporal sense, with the use of synchronous and asynchronous means of communication, supported by the Internet

to provide social interactions between instructors and students, but also between instructors themselves

Introduction

One of the main and current challenges of e-learning is that of creating distance presence in order to facilitate learning

The absence/presence dichotomy is eliminated, at least from a technological point of view

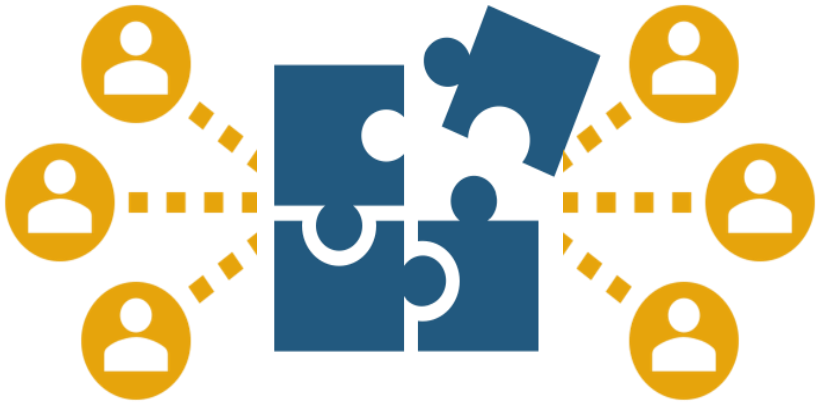
Among the studies that focus on the possibility of substantiating and qualifying the concept of "presence" in the field of e-learning, we consider the model of the **Community of Inquiry (CoI)** in e-learning proposed by Garrison and Anderson (2003)

What is a community?

- It forms around a **common objective**: *a community is a social organization that is relatively informal and flexible, directed towards a goal* (Cox, 2005).
- Its **members band together to build a collective experience** that allows them to reach this goal while pursuing their own personal objectives (Wenger, 1998; Grossman et al., 2001). From this co-construction is progressively born a micro-culture that is shared by its members and that relates to values, practices, conversational rules or even behaviour (Preece & Maloney-Krichmar, 2003; Dillenbourg et al., 2003).
- Its common space of interactions and exchanges is mainly based on the logic of **collaboration**: equality in the members' standing and their participation in the interactions, as well as the fact that they jointly carry out activities that they determined together (Henri and Lundgren-Cayrol, 2003). Also, the members actively participate and have access to common resources, while ensuring reciprocity of information, of support and of services (Preece & Maloney-Krichmar, 2003).

What is a learning community?

A learning community, whether *virtual or not*, has most of the general characteristics of a community in the wider sense.



It constitutes *a group of people, who are voluntary members with varying experience of equal value, that are constantly learning together in order to solve problems* (Jézégou, 2010).

What is a community of inquiry?

A community of inquiry is first and foremost a **learning community** whose specificity is that it relies on a problem solving process based on the general principles of the scientific method; according to Dewey and Bentley (1949), this method fosters the individual and collective construction of knowledge, but also of critical thinking.

A community of inquiry can develop if two conditions are met (Jézégou, 2008).

Each learner of the group **must be sufficiently motivated** to get involved and persevere in the interactions with the others in an effort of collaboration	**Efficiency of the strategies** that each learner of the group puts forth **to regulate, on his own**, the socio-affective, emotional and cognitive aspects of these interactions based on collaboration
• Be motivated enough to undertake to carry out collective activities, • To accept the group's modus operandi or to take into account each person's personality	• Fundamental role is played by the possibilities offered by e-learning mechanisms to create educational situations capable of encouraging this self-direction. • The instructor motivates and helps the learner to regulate his learning environment and behaviour in a collaborative logic

The two conditions have the following effects on learning:

Collaborating with others a person learns

- The collaboration is nourished through exchanges, mutual contributions, confrontations, and negotiations that provoke within the person certain interrogations and stimulate new learning through carrying out new activities.
- Self-construction exercises that allow the learner to objectify and construct his own knowledge: to clarify, structure and take possession of his thoughts.
- These operations also invite the learner to make a critical examination of the knowledge acquired through this collaborative experience, to look back at the cognitive processes he/she has used and to evaluate them.

Collaboration promotes group learning

- This collective experience allows the learner to achieve a goal: that of solving a problem combined with the formalisation and application of solutions.
- Thus, the learner is led to define a mode of operation, to adopt the principles of the scientific method, to define a strategy, to test the results arising from this process and to evaluate them.

The three key elements of the CoI framework

As far as e-learning is concerned, certain collaborative interactions contribute to creating a distant presence that favours the emergence and development of a CoI (Garrison and Anderson, 2003)

cognitive presence

"The degree to which the participants are able to construct and confirm meaning by using thought and dialogue in a learning community" (Garrison & Anderson, 2003, p.55).

social presence

The "ability of the community of inquiry participants to project themselves socially and emotionally, in all aspects of their personality, through the communication media that they use" (Garrison et al., 2000, p. 94).

→ It supports cognitive presence through the creation of an environment and of a space that encourage collaboration among learners in a problem solving process.

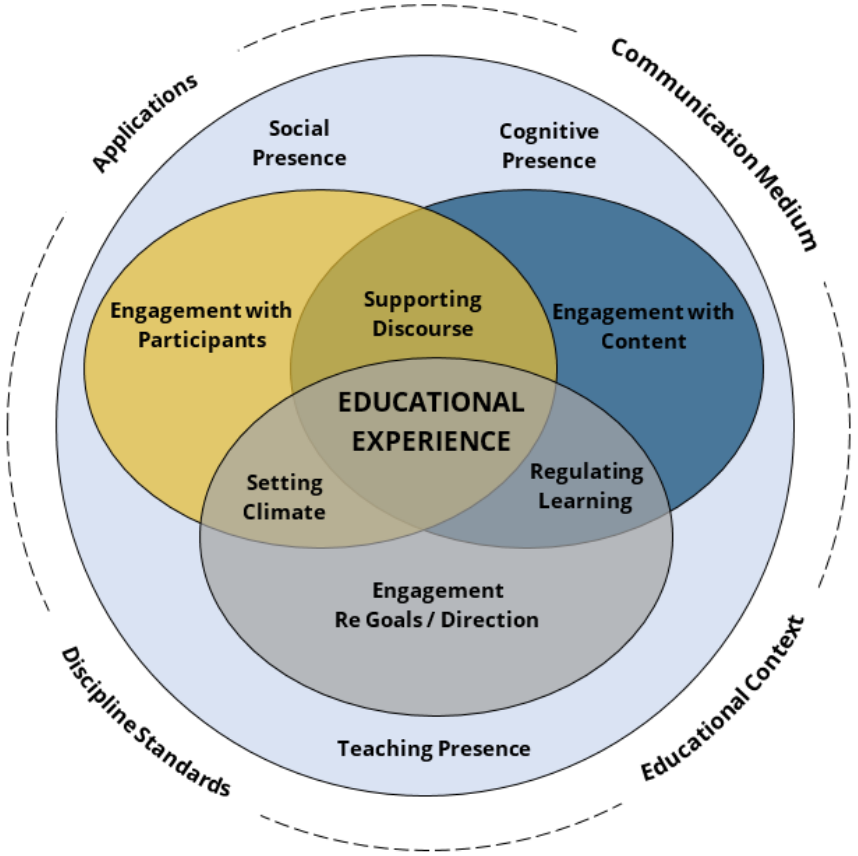
teaching presence

The role played by the instructors in the "design, facilitation and management of the cognitive and social processes from an educational point of view" (Garrison and Anderson, 2003, p. 55).

→ It is fundamental for quality collaboration between learners through the creation of organizational and educational conditions that facilitate while playing the role of mediator between learners and that of facilitator of the socio-affective environment within the group.

Conclusion

Especially in an online learning environment, where learners can easily be distracted, passive or feel isolated and disconnected from their peers and teacher, **it is important to establish connections between those three presences,** to create and maintain an active, interactive, and collaborative as well as engaging online learning environment.



Engagement and Motivation in the CoI Framework

Below, suggested activities are presented to promote engaging and interactive **activities for students to achieve a better connection with the content, the teacher, and the other students**.

Students

(Conrad & Donaldson, 2011;
Novak & Rodriguez, 2018)

- Provide icebreaker tasks/activities
- Organize team/peer assessments
- Provide collaborative tasks/activities
- Provide ways for synchronous and asynchronous communication and share contents (chatrooms discussions, forums, messages, 1-to-1 interaction tools)
- cultivate the sense of community

Engagement and motivation in the CoI Framework

Content (Conrad & Donaldson, 2011; Novak & Rodriguez, 2018; Gov.uk, 2021)	• Make students comfortable with the online tools • Minimize distractions • Provide authentic, relevant, valuable tasks/activities to the students • Provide a variety of tasks/activities that are alternated • Provide challenging tasks/activities • Provide adaptive tasks/activities to the students' needs and learning styles • Give immediate and varied feedback • Build in Rewards and incentives to make learning game-like • Create rubrics to define students' expectations • Provide options for self-regulation • Provide options for reflective self-assessment

Engagement and motivation in the CoI Framework

Teacher (Conrad & Donaldson, 2011; Gov.uk, 2021)	• Create rubrics to define students' expectations • Give immediate and varied feedback • Provide hints and comments during the activities/tasks • Provide continuous support via synchronous and asynchronous communication (chatroom discussions, forums, announcements, messages, interactive touch-screen questions in live recorded lessons)

Community of Inquiry (CoI)

ACTIVITY

In teams, select one of the presences described in the CoI framework. Find more about what the presence you chose is about and present your findings in plenary.

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E-moderation, 5 Stage Model and e-tivities

ACTIVITY

Choose a specific Mathematics topic and design e-tivities for each one of the stages of the 5 Stage Model. Take into account the examples provided in table 2.3.

Online Pedagogy Theoretical Frameworks

2.2. E-moderation, 5 Stage Model and e-tivities

E-moderation, 5 Stage Model and e-tivities

Another "*overarching framework for creating online pedagogy appropriate design of collaborative interactive learning and teaching in online environments*" (Wright, 2015, p.18) is the framework developed by Gilly Salmon, and includes ***E-moderation***, the ***5 Stage Model*** and ***e-tivities***.

✓ Educators are expected to utilise Salmon's framework in order to "*align their teaching and design practices with the CoI framework*" (Wright, 2015, p.18).

E-moderation

An **e-moderator** is someone (usually a teacher) that assists learners in making meaning from their interactions.

S/he must have the following competences (Salmon, 2011):

1. Understanding of the online learning processes,
2. Technical skills to use the software features,
3. Online communication skills (non-verbal, verbal, and written),
4. Content expertise to share with and support students' personal learning,
5. Personal characteristics such as empathy, creativity, confidence, and flexibility.

E-moderation

The transition from face to face to online environments is quite challenging, even for the most experienced lecturers and trainers (Salmon, 2011).

Despite this, e-moderators do not need many years of experience. They can and should be trained on how they can use all the available online tools to extend their teaching.

Online learning strategies must address issues that relate to online learning facilitation, tutoring and support but also to the appropriate use of online learning materials and tools to enable fruitful interactions between the teacher, the learners, and the educational material.

5 Stage Model

It is a pedagogical model for the management of online teaching, which offers "*essential support and development to learners at each stage as they build up expertise in learning online*" (Salmon, 2013, p.15).

✓ In particular, it describes how to apply the Community of Inquiry framework to develop cognitive, social, and teaching presence within five stages.

5 Stage Model

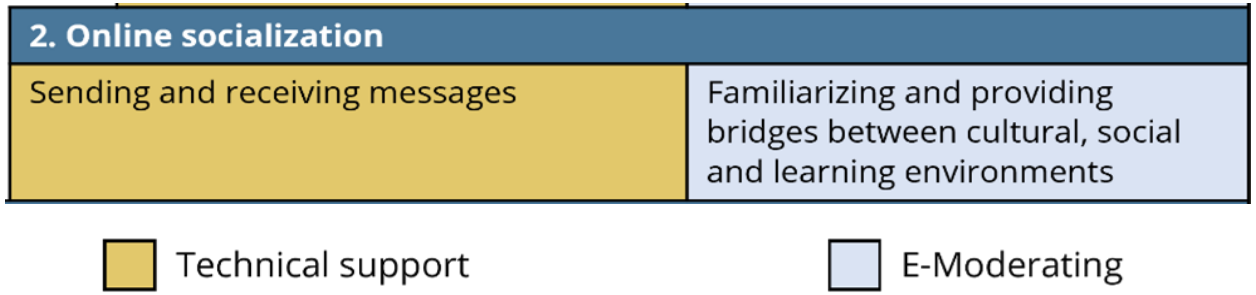
Stage 1 is about establishing access for each one of the learners and giving them reasons to actively engage and participate in the community.

✓ At this stage, learners will be unfamiliar with the online environment and tools, and they need support to feel confident and motivated.

✓ Depending on the level of familiarity they have with the online learning software in use, learners will need more or less time in each stage before progressing.

5 Stage Model

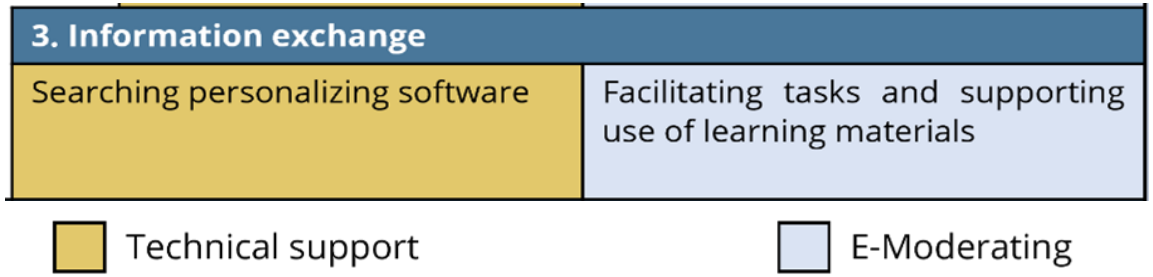
In **Stage 2** , learners establish their online identities, and they start to exchange messages with others.



✓ They need to understand the value of learning together online and ways of contributing to group work.

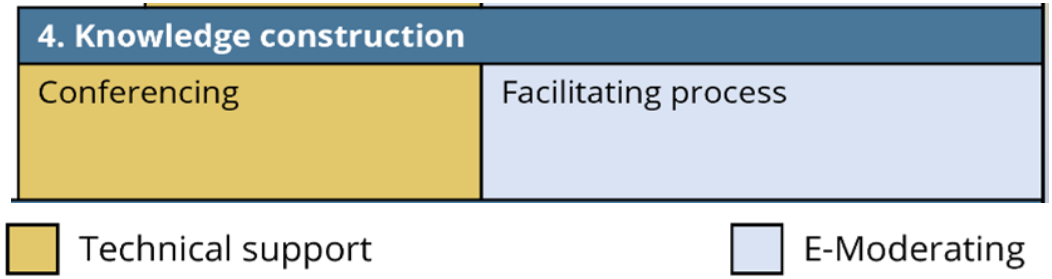
5 Stage Model

In **Stage 3** , learners interact with the course materials, and they exchange information with others, while contributing to learning at their own pace.



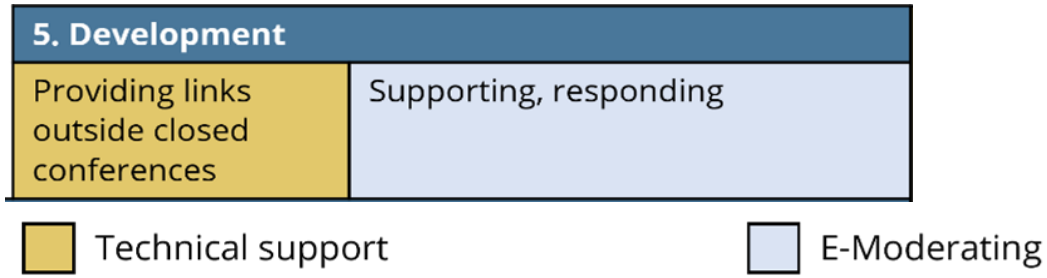
5 Stage Model

Knowledge construction begins in **Stage 4** , through course-related group discussions and small, collaborative, and sequenced e-tivities (which we will talk about shortly).



5 Stage Model

In **Stage 5** , learners feel confident to work with others online and they can fully exploit the benefits of their own learning.



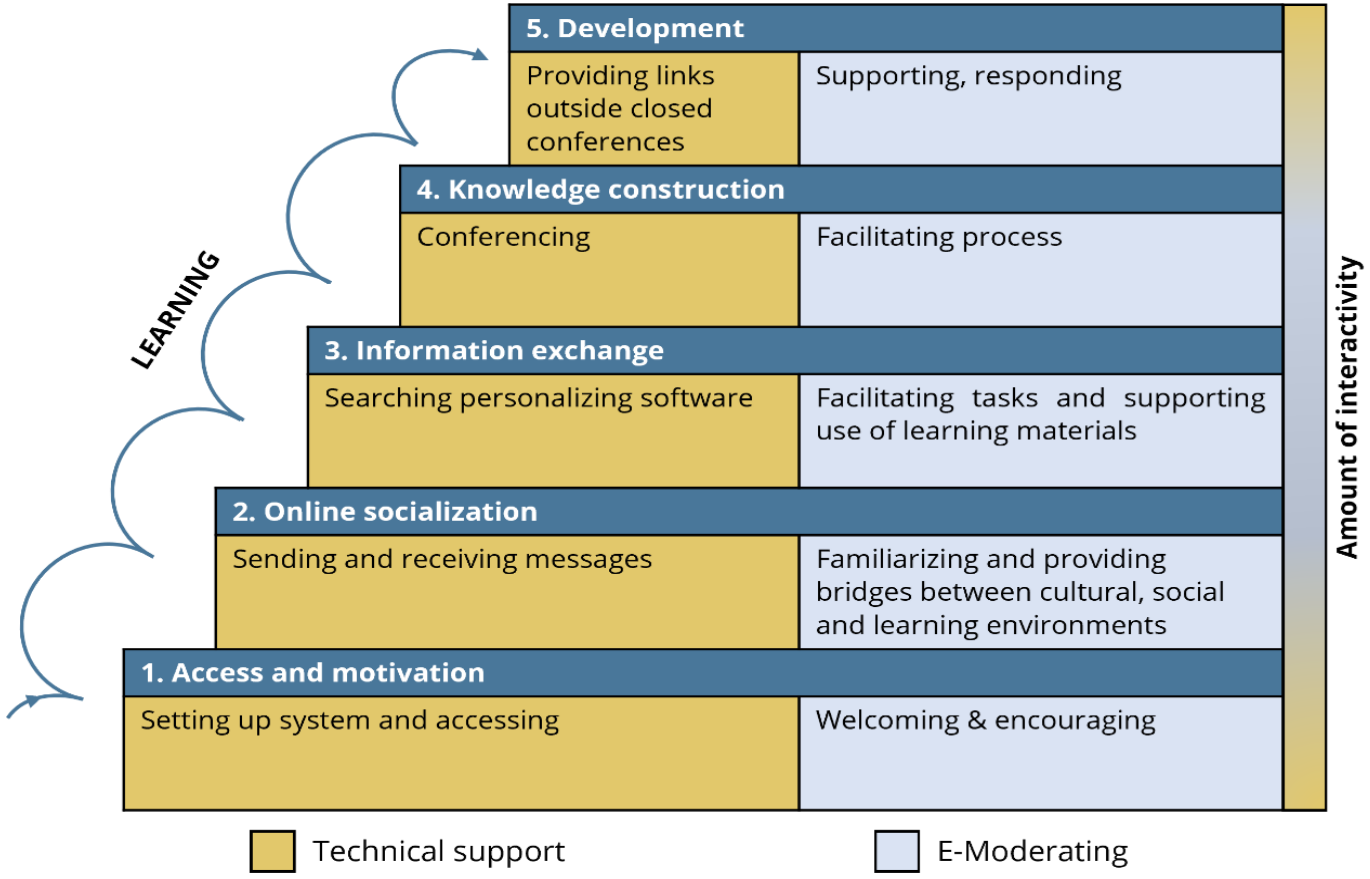
✓They are able to self-reflect and make judgments about their experience.

5 Stage Model

Each stage requires different technical and e-moderating skills.

In the first stages, learners are expected to have the minimum technical skills required to make use of the online environment, while they gradually develop more complex skills.

The main benefit of using this model is that the teacher will know "how participants are likely to exploit the system at each stage" (Salmon, 2011) to avoid common difficulties.



e-tivities

"**E-tivities**" is a model proposed by Salmon (2013) for designing activities online, that is based on the Community of Inquiry framework and on e-moderating.

E-tivities are for:

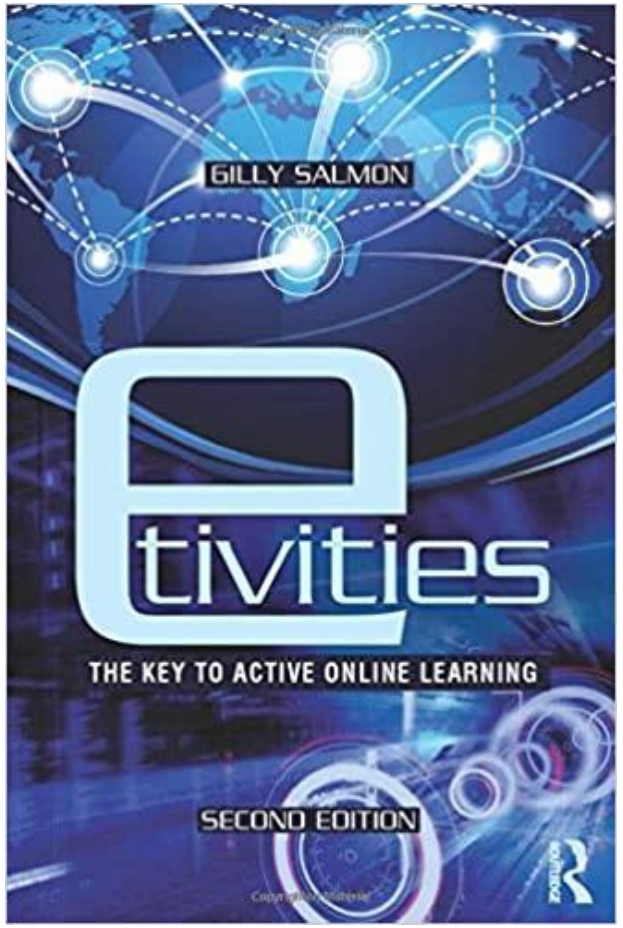
- at least two people that work or learn together, whether they are in the same location or not,
- people with special needs that can be assisted through technology,
- learning designers, academics, teachers, and trainers.

e-tivities

E-tivities can be applied to entirely online programs or to blended learning, or mobile learning environments.

They are designed beforehand and are quick and easy to produce, since they are reusable, scalable, and customizable.

To design e-tivities, designers need to think about the purpose and process of each e-tivity and create a draft storyboard. After that, they need to place it into a learning sequence, and write it in such a way that can be applied online, so that learners can follow it. That is known as “the invitation”.



e-tivities

An example of “The invitation”

Title	A brief description of the invitation. Creative but short.
Purpose	Explain what will be expected with each activity. Link with the learning outcomes and/or objectives for the unit/module/course/program.
Task summary	Clear instructions on how to participate and what to do
Spark	Ignite interest with titles and content, to start a dialogue
Individual contribution	Clear instructions for the individual participant as to what to do, in what media (e.g. wiki, discussion board) and when (day and date).
Dialogue begins	Request response from an individual to others. Use links to the response-posting location
E-moderation interventions	What will the e-moderator do and when
Schedule and time	Total calendar/elapsed time for the e-tivity, completion date, estimated total study time required
Next	Link to next activity, additional resources. Use links.

e-tivities

Here there are **indicative examples of e-tivities** that can be created for each one of the stages of the Five-Stage Model.

	Ideas for e-tivities
Stage 1	• Icebreakers • Quiz
Stage 2	• Scenarios for discussion • Introduce yourself using six descriptive words • Offer one website or blog that illustrates your favourite hobby.
Stage 3	• Debates • Practice summarizing information—for example, the theory of relativity—in 12 words • Try out some online competitive and collaborative games.

e-tivities

Stage 4	• Take a key diagram, model or concept from your course or discipline. Ask each participant to apply it or find examples. Compare and contrast between the examples offered. Draw it online and collectively improve it. • Introduce staged case-study information with questions.
Stage 5	• Offer essays, reports or collated Web or social media sites from previous students on the course (with permission or disguised, of course) and run an e-tivity on how participants would have marked, assessed and graded them. • Would the group have worked differently if it had met physically too? If so, in what way?

E-moderation, 5 Stage Model and e-tivities

ACTIVITY

Choose a specific Mathematics topic and design e-tivities for each one of the stages of the 5 Stage Model. Take into account the examples provided in table 2.3.

References

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Online Pedagogy Theoretical Frameworks

2.3. Mobile learning pedagogy

General m-learning

- Mobile learning as “any educational provision where the sole or dominant technologies are handheld or palmtop devices” (Traxler, 2005, p. 262).
- m-learning as “meaningful learning that occurs through the use of wireless handheld devices such as cell phone, personal digital assistant, mini-computer, or iPod” (Stevens & Kitchenham, (2011).
- Mobile learning definitions have shifted from technocentric to learner-centered, leading to more recent definitions that focus on the mobility of both technology and learning itself.
- Mobile learning as a way of enlightenment that can be presented ‘‘without breaking apart from life” (Yamamoto, 2013).

Math m-learning

- Mobile technologies are a recent addition and, as a result, it is quite challenging for teachers to create didactical situations that promote positive pedagogical relationships and interactive behaviors.
- “The potential for visual, interactive engagement with some learning experiences, coupled with the haptic and oral/aural affordances of the technology, change the nature of the Mathematical activity” (Calder et al., 2018).
- A study by Dahler (2010) focused Mathematical knowledge of middle school students using mobile devices outside the classroom. Good results by solving authentic problems in a mobile phone environment.

Math m-learning

Benefits	Difficulties	Favourite Aspects of Teaching Math Online
Detailed	Cheating	Flexibility
Flexibility	Attrition (in terms of dropout rate)	Interactive Tools
Self – Sufficient	Student Feeling of Isolation	Meeting Students' Needs
Variety	Graphing	Student Diversity
Personalization	Typing Accurate Mathematics	Teaching Resources
Pacing	Interfacing with Online Environment	
Resources	Difficulty With Building Relationships with Students	
Differentiation		
Convenience		
Accommodating		

Math m-learning

ACTIVITY

In small teams, using your mobile devices:

A. Visit DESMOS (https://www.desmos.com). Select the graphing calculator and try to create a small house with a roof. Alternatively, select the Math Tool of your choice and create a short mathematics activity. Discuss your experience.

B. Create a simple Augmented Reality experience by using one of the following AR apps. You can add links to YouTube videos or webpages similar to the subject you choose.

Blippar https://www.blippar.com/
Zappar https://www.zappar.com/

C. Create a simple Augmented Reality experience for Mathematics teaching, by using:

GeogebraAR (https://www.geogebra.org/m/R8Qd7U8y) or
Photomath (https://photomath.com/en/)

ASYMPTOTE's pedagogical model principles

Adaptivity	Teachers compile task sequences (which in ASYMPTOTE are called learning graphs) from a selected set of tasks with adaptive elements. Tasks and learning graphs (see chapter 3.5) are tailored to students' needs and individual educational level
Barrier-free online Mathematics education	Marked tasks with formulation given in an easy language to support students with less profound language skills. Zoom in pictures, and task formulation read out for students with visual impairment
Synchronous online learning & personal communication	Pre-defined timespan in which synchronous online learning will take place in a Digital Classroom environment. Functionalities that exchange information between learner's progress and teacher's web interface. Information about student's progress in real-time. Helping hints, support, and feedback

ASYMPTOTE's pedagogical model principles

Long-term assessment	Automated evaluation of the conducted learning session. Graphical and numerical outputs on students' performance.
Rich repository of high-quality student tasks	The web portal provides access to a repository with high-quality student tasks on different Mathematics topics for secondary and university level.
1-to-1 learning providing immediate feedback	Students solve tasks that are embedded in a learning graph designed specifically for their needs and educational level and they can interact with the teacher individually to receive immediate feedback.

ASYMPTOTE's pedagogical model principles

ASYMPTOTE…

… being a 1-to-1 interaction tool, offers students the flexibility to solve individually and at their own pace a selected set of tasks that are embedded in a learning graph by the teacher.

… attempts to be inclusive, by adding marked tasks with formulations given in an easy language to support students with less profound language skills.

…. supports students by providing a Digital Classroom environment, in which they can communicate and interact with each other in chatrooms and ask for feedback from the teacher.

… is compatible with the CoI framework, manages to create a deep and meaningful educational experience through collaborative and constructivist approaches.

ASYMPTOTE's pedagogical model principles

ASYMPTOTE's pedagogical principles can be summarized as:

1. Learners are provided with engaging and interactive tasks that are adapted to their educational needs.
2. Learners build fundamental knowledge by solving training or learning tasks and they deepen their understanding by solving reasoning tasks (see chapter 3.5).
3. Learners construct their own meaning when solving tasks for modelling (see chapter 3.5).
4. Learners interact and maintain their social skills in a supportive, digital, inclusive environment.
5. Teaching using ASYMPTOTE is a long-term enterprise aiming to build an online CoI using the 5-Stages process model.
6. Teachers facilitate learning through ASYMPTOTE in combination with any other technique to provide real-time individual feedback, support, and assessment by monitoring learner's progress through the data provided by the system about their performance.
7. Teachers' presence is visible and maintained both in a synchronous and an asynchronous environment.
8. ASYMPTOTE's tasks provide the means to maintain cognitive presence.
9. Teachers' role shifts from explaining Maths in the classroom to setting a learning environment for the students to build Mathematical knowledge. Direct teaching is delivered through videos, while practice, knowledge reinforcement and problem solving are implemented through the ASYMPTOTE app by moderated sessions where teachers provide support and feedback by text message synchronous communication.

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Teaching and Learning Design for ASYMPTOTE

3.1. Teaching as a design science

Teaching as a design science

"Teaching is more like a design science because it uses what is known about teaching to attain the goal of student learning and uses the implementation of its designs to keep improving them" (Laurillard, 2012).

Teaching as a design science

Teaching is a form of a design *"that uses a distinctive mode of thought and set of tools and methods".*

Goodyear (2015)

Three key learning design components in Goodyear's model:

- Good **tasks** (the key building block for pedagogical patterns)
- Supportive physical and digital environments (**Tools, artefacts**)
- Modes of social organization and divisions of labour (**People**)

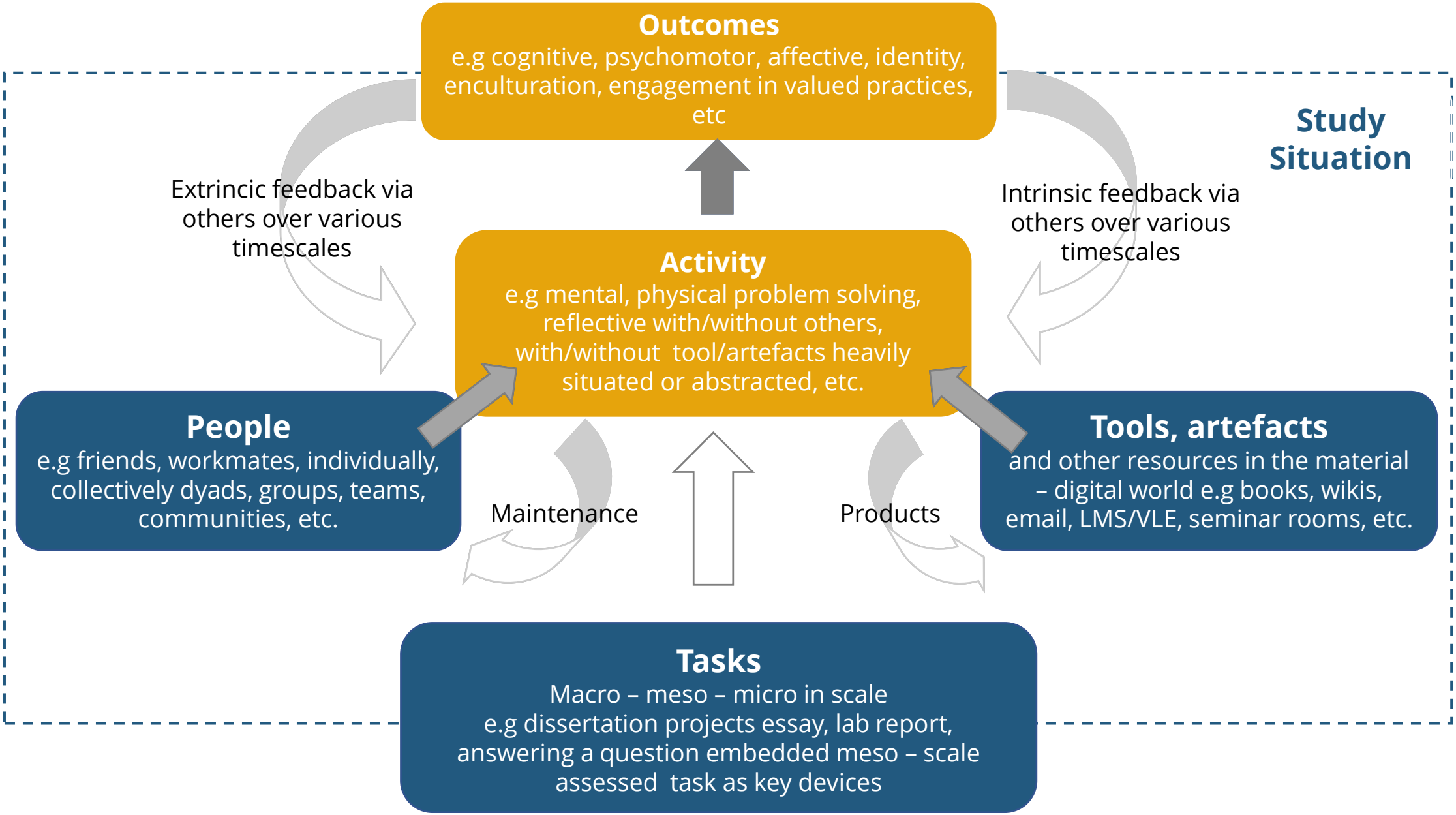

Figure 3.1. Goodyear's activity-centered design model (Goodyear, 2015).

Teaching as a design science

Learning activity is the unique experience each student has

To implement a task :

- explore and reshape the learning environment
- use the tools and resources provided
- Interact with other people for the task completion

✓ students **actively participate** in the learning process, **making their own meaning** in the context of the **learning activity**

References

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Teaching and Learning Design for ASYMPTOTE

3.2. Pedagogical scenarios – Learning scripts

Pedagogical scenarios – Learning scripts

Pedagogical scenario or Learning script Is

a) a set of learning resources

b) the description of learning environment

c) a set of instructions that define the learners' interactions to complete a sequence of tasks

d) description of everything needed for their implementation

(Dillenburg, 2002).

- ✓ There are many ways to represent a pedagogical scenario since there is not a commonly acceptable standard form.
- ✓ The sequence of tasks/activities usually follows traditional models. However, **in the context of ASYMPTOTE**, it is focused on **student-centered models**.

Learning design patterns

✓ Design patterns have the potential to make a major contribution to the sharing of techniques and expert knowledge among developers of learning activities and teachers.

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Teaching and Learning Design for ASYMPTOTE

3.3. General Pedagogical Patterns

General Pedagogical Patterns

Pedagogical patterns "*describe the experience of experts for various successful practices in the field of teaching and learning*" (Hadzhikolev et al, 2021)

- support teachers in the preparation and implementation of a learning process
- help them create meaningful learning experiences.

✓ in the context of **ASYMPTOTE**, special design patterns will rise and existing will be adopted such as Collaborative Learning Flow Patterns (CLFPs) (Hernández-Leo et al., 2005)

Collaborative Learning Scripts

These patterns, or scripts, “represent broadly accepted techniques that are repetitively used by practitioners when structuring the flow of learning activities involved in collaborative learning situations” (Hernández-Leo et al., 2006).

DEFINITION

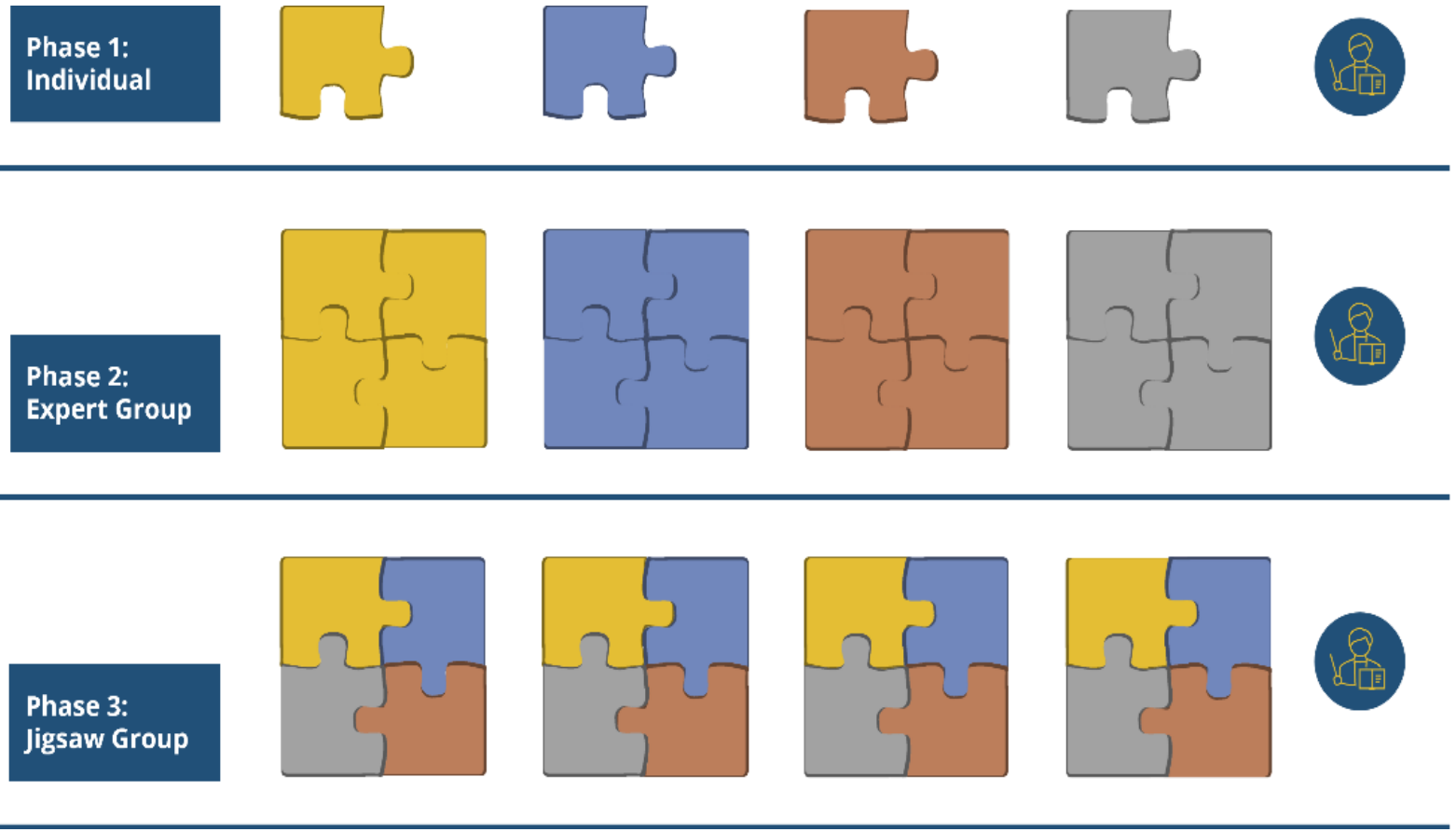
Collaborative Learning Script: is a set of instructions prescribing how students should form groups and how they should interact and collaborate in order to solve a problem (Dillenbourg, 2002).

The Jigsaw collaborative pattern or script

work individually on sub-problem

meet in Expert Groups to exchange ideas

return to Jigsaw Groups to find solution to the whole problem

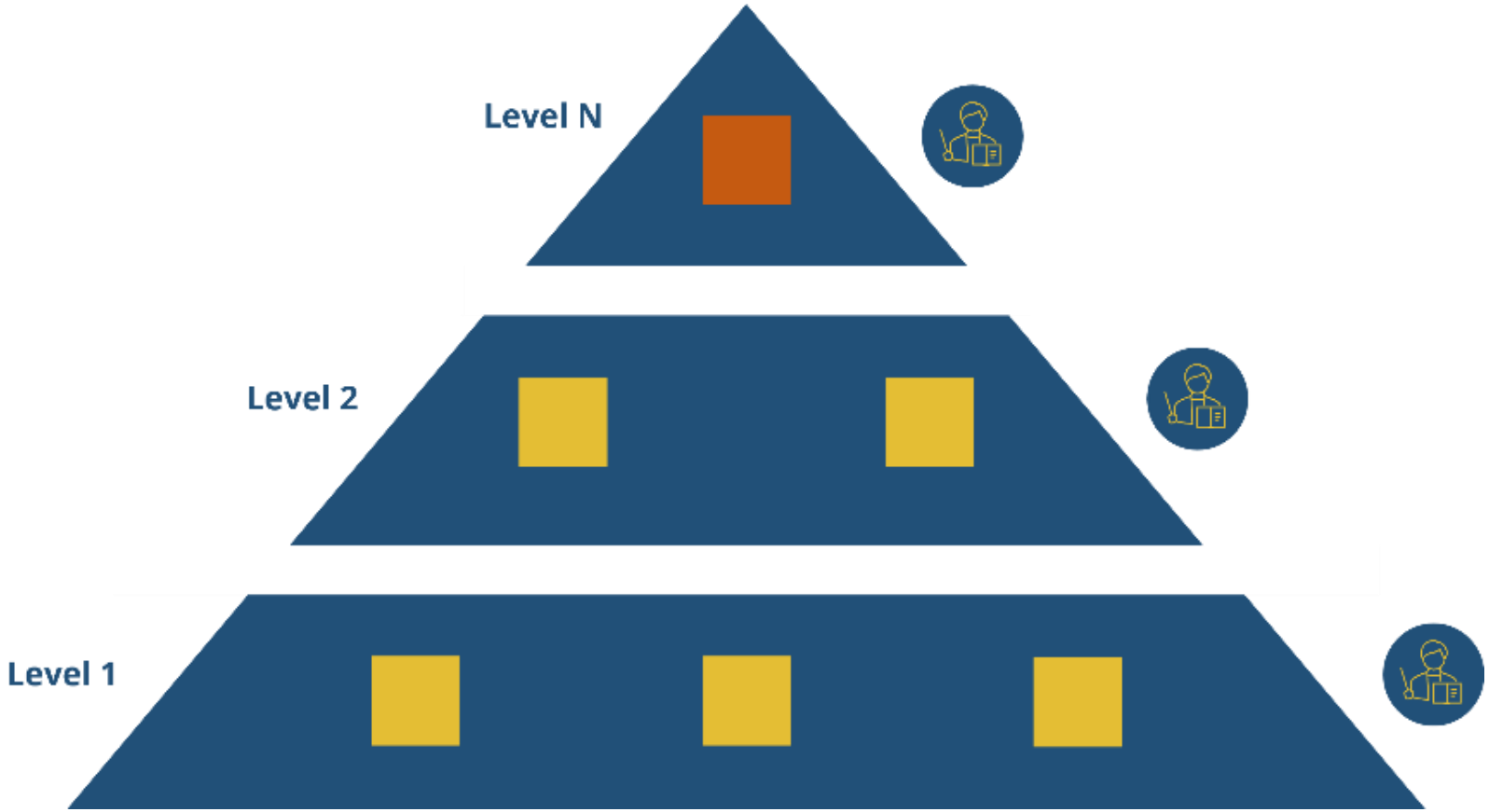


The Pyramid collaborative pattern or script

all students propose a final and agreed solution

meet in larger groups, discuss their ideas & generate a new proposal

study individually, or in small groups, the problem they propose a solution

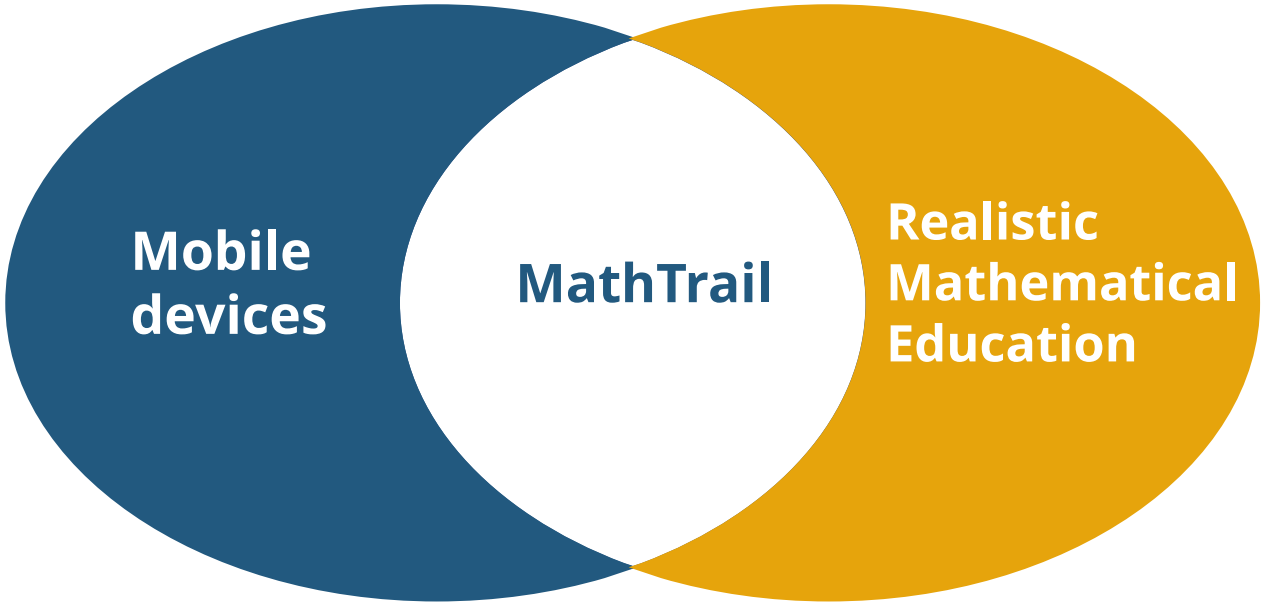


The MathTrail as a pattern of a learning activity

A pre-planned path

A sequence of stops

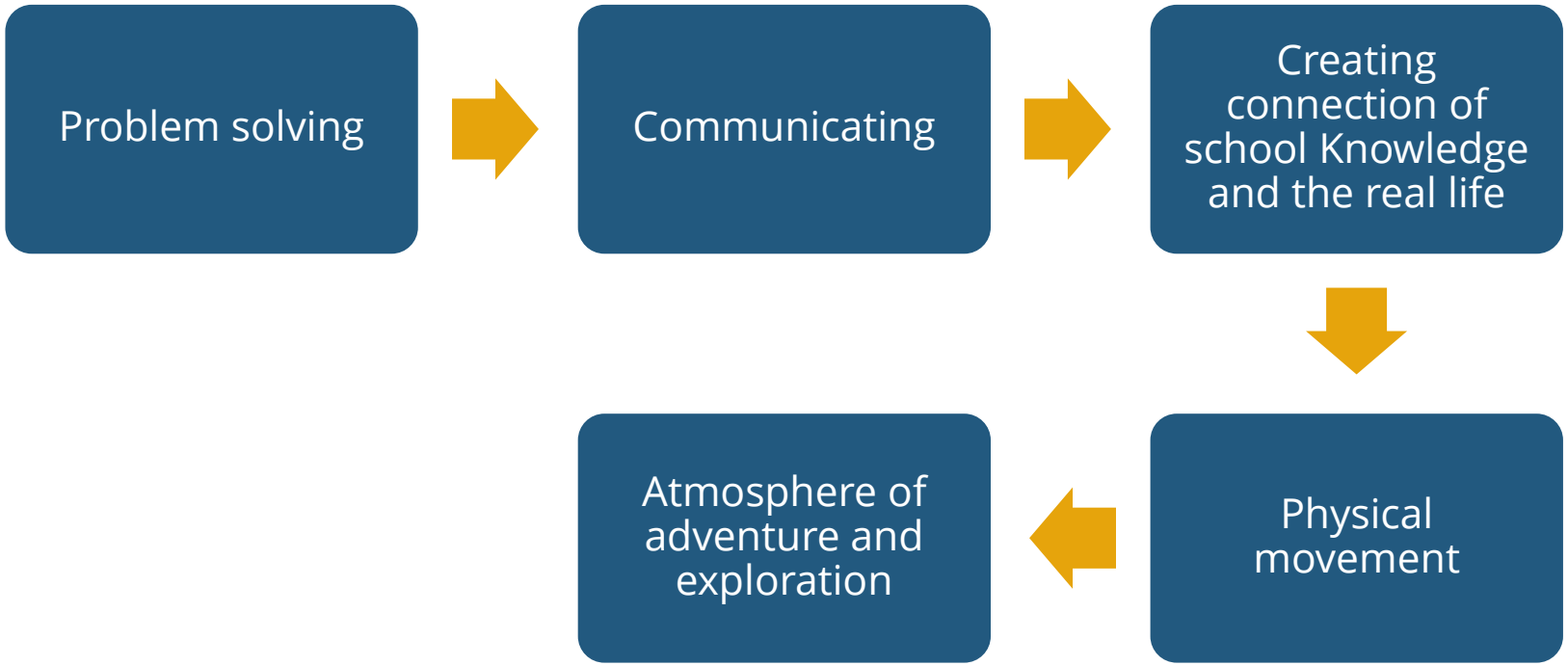
Examination of Mathematics in real life



The MathTrail as a pattern of a learning activity

A Mathematical trail is a model of learning activity that combines

- A pre-planned path
- A sequence of stops
- Examination of Mathematics in real life



3.3.1. Pedagogical Patterns in ASYMPTOTE

ASYMPTOTE, since it is offered as a web-portal with access to a high-quality tasks repository allows the **implementation of various pedagogical patterns for Mathematics teaching**

Compatible with ASYMPTOTE learning design patterns

- Gagne's Nine Events of Instruction
- Study-Reinforce-Apply-Extend pattern
- The MathTrail pattern
- The Learning Graph pattern etc.

✓ Explore learning design patterns utilizing ASYMPTOTE

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Teaching and Learning Design for ASYMPTOTE

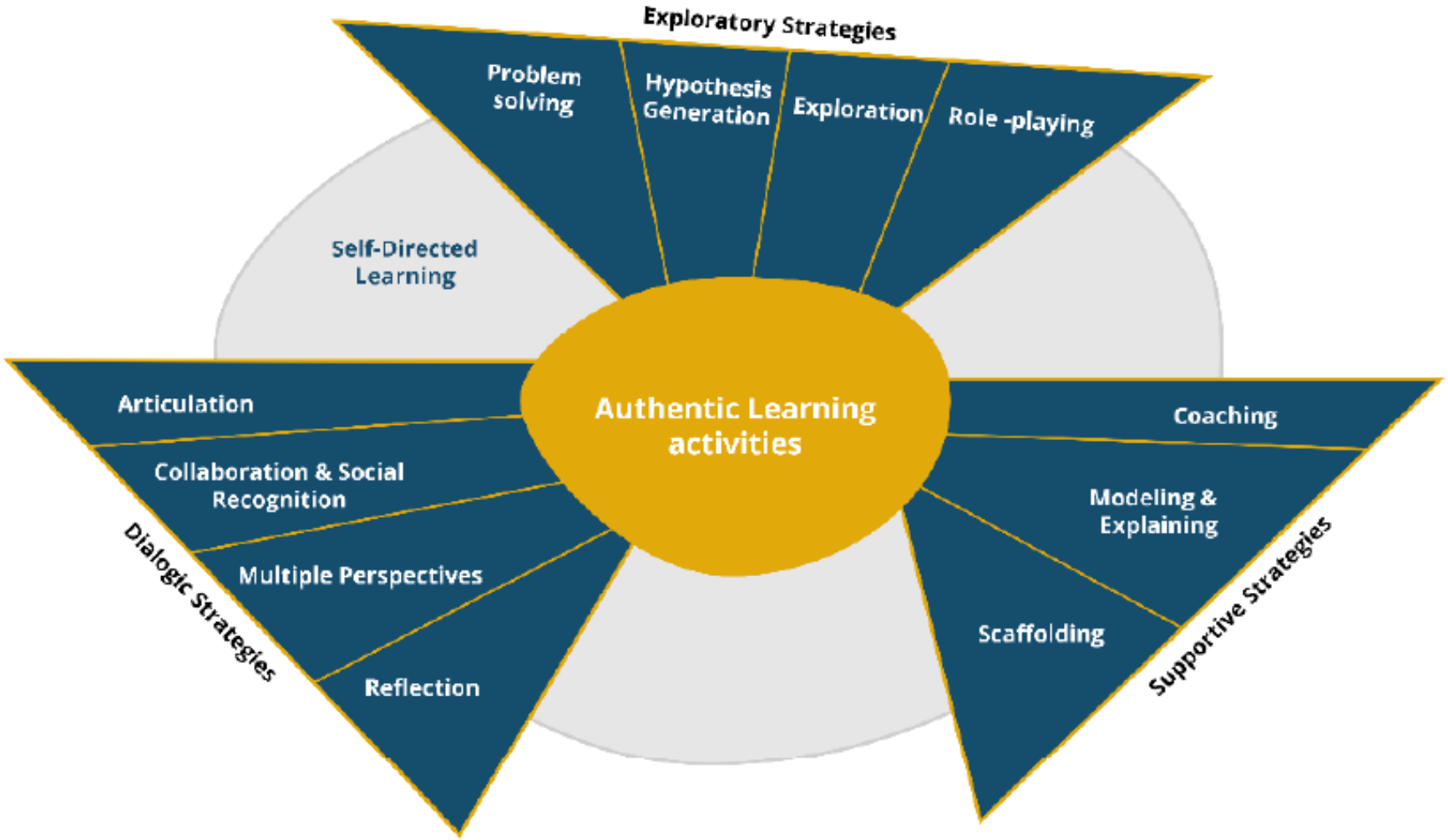
3.4. Online teaching strategies – methods and pedagogical practices

Pedagogical Strategies

- Teaching methods and pedagogical practices to align with constructivist-based pedagogical models according to the properties and needs of online-remote educational settings.
- For a pedagogical model in an online learning context, it is important to “identify specific instructional strategies that support the model characteristics and to enact these strategies by using Web-based technologies” (Dabbagh & Bannan-Ritland, 2005, p. 201).
- Instructional strategies are all the techniques an instructor or an instructional designer uses to engage the students and facilitate learning.

Pedagogical Strategies

- Instructional strategies that support constructivist-based pedagogical models (Dabbagh & Bannan-Ritland, 2005, p. 206).



Pedagogical Strategies

DEFINITION

Exploratory strategies: strategies that promote exploratory-type activities (problem-solving, exploration, hypotheses generation and role-playing, modelling).

Dialogic strategies: strategies that promote dialogic activities (engaging students in articulation, reflection, collaboration, and multiple perspectives).

Supportive strategies: strategies that are usually enacted by the instructor, to model the desired performance, skill, or process, but also to support students during the execution of a task (Dabbagh, 2005).

Pedagogical Strategies

- When students are engaged in instructional strategies, they manage to make meaning and learn through authentic situations that are relevant to their needs and interests.
- Hodgen et al. (2020) found that remote practices in England offered less opportunities to students to interact with each other and with the teacher during their learning.
  Results:
  (1) Limitation of opportunities for feedback, interaction with teachers, for pupils to engage in metacognitive tasks or to express their Mathematical ideas verbally.
  (2) Identification of a gap between pupils from more and less disadvantaged backgrounds is likely to increase substantially as a result of the school closures.
- It is important to get more experienced with the interactive tools and resources, to get more familiar with the features that are provided in an online environment.

Feedback strategies

- The term feedback generally refers to information that is provided after a process has been completed and is intended to have a regulating effect (Narciss, 2006, p. 14).
- Situations feedback includes information presented to students by external sources of information.
- A basic distinction is made between informative feedback and motivational feedback.

DEFINITION

Informative feedback includes information offered with the aim of helping students to solve a task correctly and to cope with similar learning situations in the future (Narciss, 2006, p. 18).

The **effects** of informative feedback are described in four complementary functions. Feedback can be used as a reinforcer of correct answers and as a source of motivation, it can provide information about mistakes with the aim of correction and can also be understood as a tutor in the processing of tasks (Narciss, 2006, p. 24-37).

Feedback strategies

Classification of feedback (Narciss, 2006, p. 19)

- Knowledge of performance (KP): Learners receive summative feedback on the level of performance achieved (e.g., 60% of tasks correctly solved).
- Knowledge of the result/ response (KR): Indication of whether the answer is correct or incorrect.
- Knowledge of the correct response (KCR): A correct answer or solution is presented.
- Answer until correct or multiple try feedback (AUC/ MTF): The learner receives KR and is offered the opportunity to repeat the task (for AUC until the correct answer is given; for MTF there is a fixed number of attempts before KCR is offered).
- Elaborated feedback (EF): KR or KCR is used in combination with additional information to correct mistakes and solve similar tasks in the future.

Feedback strategies

Classification of different elaborated feedback components (Narciss, 2006, p. 23)

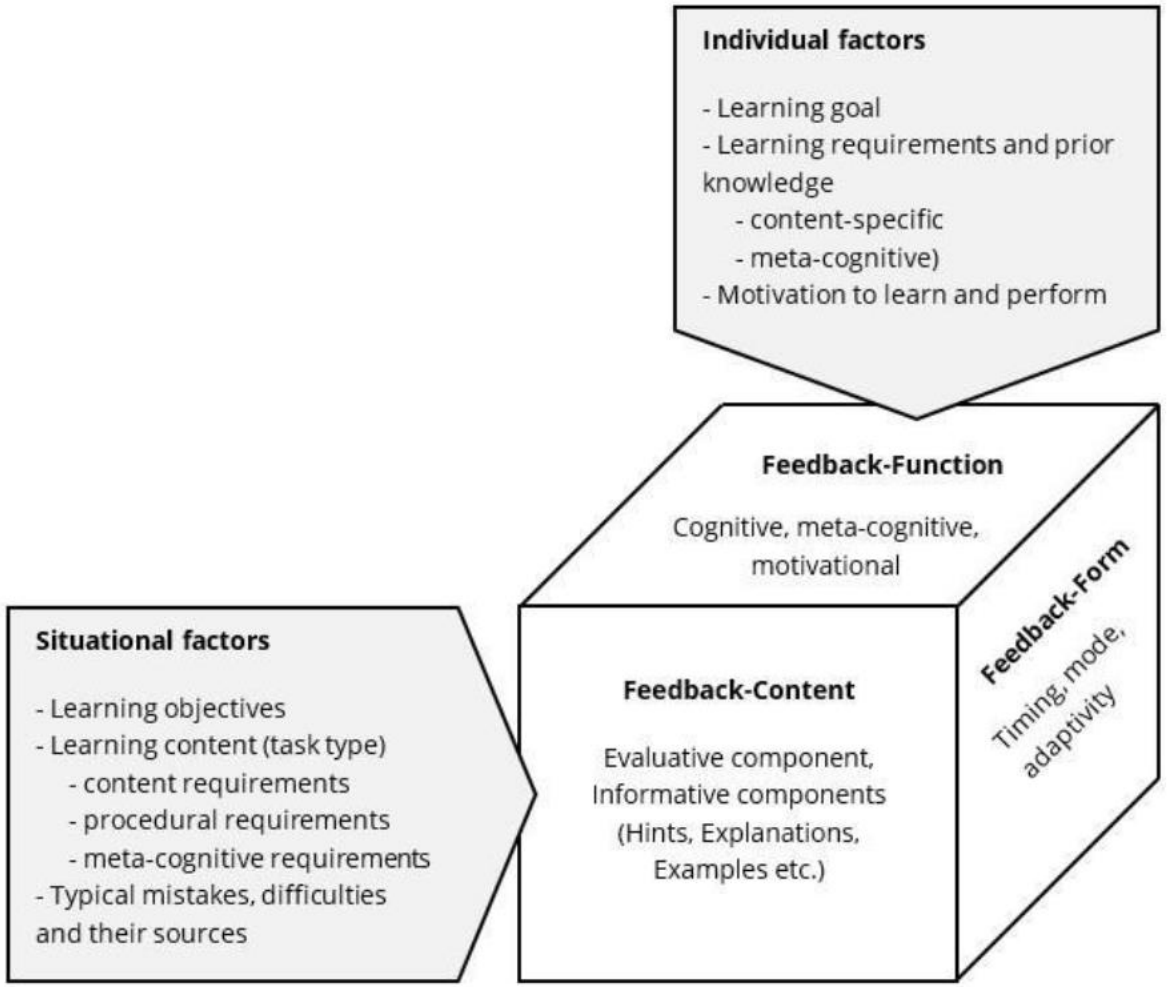
Elaborated Feedback Components	Knowledge on task constraints	KTC	Hints/ notes on... a) type of task, b) processing rules, c) subtasks, d) task requirements
	Knowledge about concepts	KC	a) Notes on technical terms, b) Examples of terms, c) Notes on the context of terms, d) Explanations of terms
	Knowledge about mistakes	KM	a) Number of errors/ mistakes, b) Location of the mistake(s), c) Type of mistake(s), d) Cause(s) of the mistake(s)
	Knowledge on how to proceed ("Know how")	KH	a) Mistake-specific correction hints, b) Task-specific solution hints, c) Hints on solution strategies, d) Guiding questions, e) Solution examples
	Knowledge on meta-cognition	KMC	a) Hints on meta-cognitive strategies, b) Meta-cognitive guiding questions

Feedback strategies

- Meta-analyses show that the use of feedback as opposed to no feedback clearly has positive effects on learning processes.
- Regarding the different types of feedback, scientific findings so far have been inconsistent (Schimmel, 1983; Clariana, 1993; Bangerts-Drowns et al., 1991).
- Trends show that feedback consisting of at least the correct solution (KCR) is more effective than feedback type KR (Bangerts-Drowns et al., 1991).
- Several studies show that the use of elaborated feedback (EF) is more effective than no feedback, knowledge of result and knowledge of the correct response (McKendree, 1990; Birenbaum & Tatsuoka, 1987).
- The use of more elaborated feedback that goes beyond the presentation of a solution (Staiger, 2016, p. 70-78; Narciss, 2006, p. 42-65).

Feedback strategies

Design principles according to Narciss (2006, p. 81-83).



Feedback strategies

The selection and specification of feedback components follows five steps:

1. Concrete teaching and learning objectives are selected based on the curricula.
2. Typical student tasks are assigned to the specified learning objectives.
3. Due to the multidimensionality of tasks, requirement analyses for the typical tasks are carried out in the third step. The following questions are to be answered:
    a. What prior knowledge is necessary to be able to solve the tasks?
    b. Which cognitive operations must be mastered (e.g., remembering, transforming, reasoning, inferring)?
    c. What meta-cognitive strategies are helpful in the context of mastering the tasks?
4. The next important step is the mistake analysis, in which typical mistakes are identified and responsible task requirements are to be found.
5. The results of task and mistake analyses are used to construct helpful information for mastering the student task and correcting mistakes (Narciss, 2006, p. 85-87).

Feedback strategies

Principles for the presentation of feedback components (Narciss, 2006, p. 269f.)

- Feedback should only be provided after the task has been completed.
- Eelaborated feedback components should not be offered directly with knowledge of the correct response (KCR).
- Complex feedback content should be presented successively – from initially strategic information to progressively more concrete information.
- Learners should be given the opportunity to use feedback information for a next attempt to solve the problem (MTF).
- One other task of the same type should be set to have the knowledge acquired with the help of the feedback applied.

Feedback strategies

ACTIVITY

Select a student task based on your curricula. Design feedback following the five steps to select appropriate feedback components. Think of three hints (EF) and KCR.

Additional guiding questions:

Should MTF be available for your task?
When will KCR be presented?
Did you think about implementing strategic and concrete information as feedback components?

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Teaching and Learning Design for ASYMPTOTE

3.5. Tasks Design for Mathematics learning using ASYMPTOTE

Tasks in Mathematics

- In Mathematics education designing, selecting, modifying, using, sequencing, observing, and evaluating **tasks takes a big part of teaching and learning** processes (Margolinas, 2013).

- **Task design lies in the center of Mathematics'** methodology and pedagogy because task engagement brings learners across Mathematics concepts, ideas, strategies and helps them develop Mathematical thinking (Artigue & Perrin-Glorian, 1991).

The term task

The term “task” can be found in the literature having **different interpretations**.

- a task as an operation bound with specific restrictions and requirements (Leont’ev, 1978);
- as something that the learners are requested from the teacher to do (Mason & Johnston-Wilder, 2006);
- describe material or environments which are destined to promote activities (Becker & Shimada, 1997).

DEFINITION

Margolinas, (2013) defines task as any practice, construction, problem solving, decision between different possibilities, experimentation, or inquiry, that can incite teaching and learning. The term does not refer only to something that the teacher requests from the learners to do, but it also includes whatever the learners decide to do on their own.

Tasks in ASYMPTOTE

Tasks in **ASYMPTOTE** are divided into 4 broad categories regarding their focus:

- **Learning** and **training** tasks include Mathematics and/or Mathematical techniques;
- **Reasoning** tasks require the student to use a Mathematical argument, interpretation, or explanation;
- **Modelling** tasks have a strong connection to the real world. This connection can range from easy standard modelling up to real-world- problem solving. Modelling tasks usually include a picture for identification in the corpus of the task. This picture has to be an obvious connection to reality.

Tasks in ASYMPTOTE

Designing tasks in **ASYMPTOTE** system:

Sample solution of the task - should be detailed enough that students can compare their own solution with it and be able to understand the thought process of the creator. The format of the solution can be either in text or image.

Hints for the tasks - Each task can have up to 3 hints and their purpose is to provide guidance in order to help students reach the assigned outcome. The format of a hint can be text, image or video.

Tasks in ASYMPTOTE

Answer types supported by the **ASYMPTOTE** system

- **Exact value**;
- **Interval** - especially useful when the answer cannot accurately be calculated e.g. for more complex modelling tasks;
- **Multiple choice** - this category also includes the answer type of true or false;
- **Fill in the blanks** - the basic requirement when designing a task with this answer type is that the student should have no difficulty in understanding the data and the question asked despite the blanks;
- **Vector (exact value)** - useful in finding the coordinates of a point;
- **Vector (interval)** - used when the coordinates cannot be accurately calculated;
- **Set** - the solution set can contain several elements. A typical example is an equation that has many solutions;

Task Metadata in ASYMPTOTE

- Every task can be described by **Mathematical tags** so that both teachers and learners can easily identify and select them;
- Each task is also addressed to a stage of **thematical hierarchy**.

  The ASYMPTOTE curriculum that was created after analysing comparing and combining the constituted curriculums for Mathematics in Italy, Germany, Greece, Portugal, and Spain, defines the hierarchy of the tasks.

- The tasks are divided into four main **categories**:
  - primary;
  - lower secondary;
  - upper secondary;
  - university.

3.5.1 Task sequences and Learning graph

DEFINITION

A learning path is defined as a sequence of tasks which are designated to assist the student in improving their knowledge or skill in a particular subject area (Brusilovsky, 1992; Yang, & Lau, 2010).

Task sequences and Learning graph

Margolinas, (2013) defines 3 types of **sequences in Mathematics** education:

i) the first type maintains the problem formulation throughout the sequence while the numbers selected for each task increase the complexity gradually;

ii) another type of sequence is one where the problem is presented progressively more complex, by the addition of steps or variables;

iii) the third type is related to the topic of Mathematics that is under examination. For example, if the topic is the calculation of the area of geometric shapes, the tasks could start with simple shapes and progress to composite and irregular shapes.

Task sequences and Learning graph

In **ASYMPTOTE** task sequences are presented in the form of a **learning graph**. This format includes 3 main categories of tasks:

- **main tasks**
- **support tasks**
- **challenge tasks**

✓ The learning graph is represented visually by a kind of fishbone diagram which consists of a central spine, where the main tasks lie and branches that connect it with the subtasks (challenge and support)

Student successfully solve a main task

- **move to a challenge task**

  → redirected to the next main task

- **continue with the next main task**

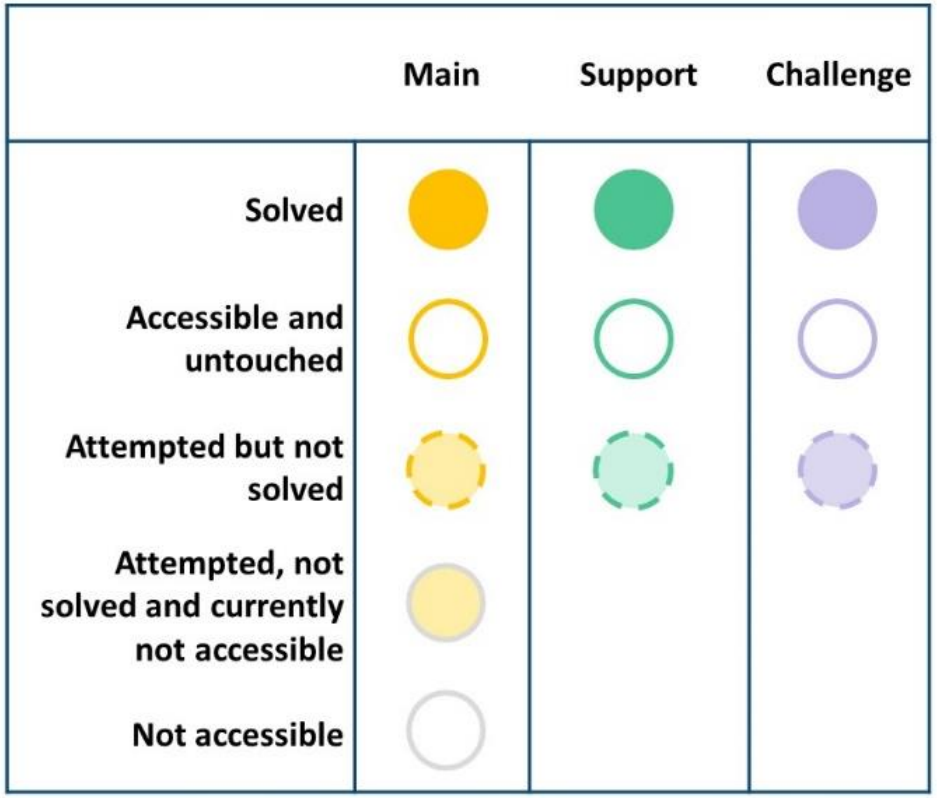
Student is not able to solve a main task

After his 2nd try

- **system will provide a support task** (if one is assigned by the teacher)

Task sequences and Learning graph

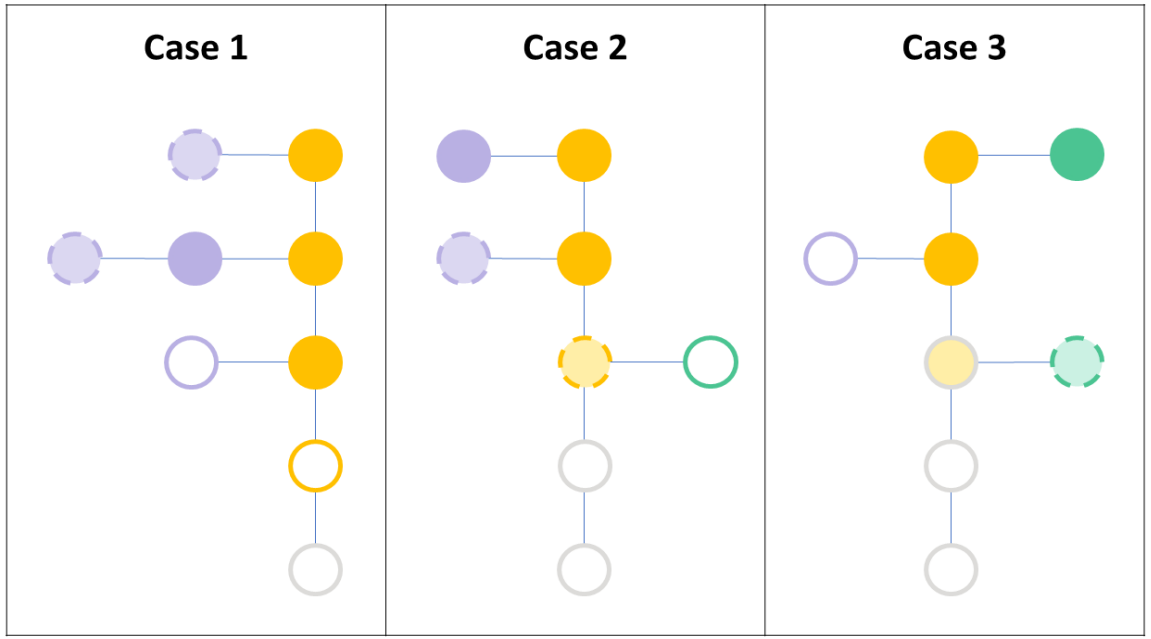
Representations of the possible states of the three main task types



- Note: The following tables do not contain realistic visuals from the App or the web portal.

Task sequences and Learning graph

Indicative cases of students' journey in a learning graph



- ✓ The number of challenge or support tasks that can be assigned to a main task depends on the creator of the learning graph.

- ❖ Note: The following tables do not contain realistic visuals from the App or the web portal.

3.5.2 Adaptive task sequences in ASYMPTOTE

DEFINITION

As Slavuj et al. (2017, p. 65) specify, *"Adaptivity in instructional systems can be broadly defined as the ability of a system to adjust instruction based on learner abilities and/or preferences, at any particular point of the instruction process, with the goal of acting on identified learner characteristics and improving the efficiency and efficacy of learning."*

Automatizations built in the ASYMPTOTE system give the opportunity to the teachers to adapt the learning processes to each student, according to their performance (Barlovits et al., 2022).

Adaptive task sequences in ASYMPTOTE

Adaptive learning systems focus on personalizing the learning processes in order to improve or accelerate students' performance (Oxman & Wong, 2014)

ASYMPTOTE system, allocates tasks for the user based on their performance in previous tasks.

- Advanced tasks appear to students who have successfully solved the main tasks, making learning challenging.
- Advanced tasks are also optional, thus learning does not get intimidating for the user.

Adaptive task sequences in ASYMPTOTE

Adaptive learning systems focus on personalizing the learning processes in order to improve or accelerate students' performance (Oxman & Wong, 2014)

ASYMPTOTE system, follows the idea of micro adaptivity with ongoing measurement of student work progress (Plass & Pawar, 2020).

- it validates the students' entered solution i.e. giving corrective feedback
- thus allocates the next task depending on its correctness

Adaptive task sequences in ASYMPTOTE

Adaptive learning tends to (Oxman and Wong, 2014):

- **achieve outcomes more effectively:**

  ASYMPTOTE, offers the possibility to the students to use hints or supporting subtasks (Intermediate), when they encounter difficulties. This function of the system provides the users with the missing knowledge and thus increases the effectiveness of the student towards the achievement of the set learning outcomes.

- **help teachers with educational processes (providing useful information, conserving time etc.):**

  ASYMPTOTE, from a teacher's perspective, contributes by providing the means to create tasks fitting to the requirements of each student. The repository of tasks and the user-friendly learning graph function, allow teachers to design individualized learning experiences for their students quickly and efficiently. Moreover, the system provides graphical and numerical outputs about students' performance on the completed learning graphs, helping both the teacher and the student have a clear image of the development of the teaching and learning process.

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Introduction to ASYMPTOTE

4.1. The ASYMPTOTE Idea

Motivation & Background

- COVID-19 pandemic
  - „Emergency Remote Teaching (ERT)“ (Hodges et al., 2020)
  - Teachers facing lack of technical training (Barlovits et al., 2021)
  - Increased use of basic reproduction tasks & lack of feedback (Barlovits, 2021; Drijvers et al. 2021)

ERT and its challenges:
- Technique & application
- Diagnosis & support
- No personal contact
- Reproduction tasks

(Aldon et al., 2021; Barlovits et al., 2021; Drijvers et al. 2021)

Motivation & Background

- COVID-19 pandemic
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- MCM@Home concepts
  - First concept for using MathCityMap for online teaching & learning

ERT and its challenges:
- Technique & application
- Diagnosis & support
- No personal contact
- Reproduction tasks

(Aldon et al., 2021; Barlovits et al., 2021; Drijvers et al. 2021)

MCM

(Ludwig & Jablonski, 2021)

MCM@Home

(Barlovits et al., 2021)

Motivation & Background

- COVID-19 pandemic
  - „Emergency Remote Teaching (ERT)“ (Hodges et al., 2020)
  - Teachers facing lack of technical training (Barlovits et al., 2021)
  - Increased use of basic reproduction tasks & lack of feedback (Barlovits, 2021; Drijvers et al. 2021)
- MCM@Home concepts
  - First concept for using MathCityMap for online teaching & learning
- ASYMPTOTE-Projekt
  - Consideration of criteria for the development of online learning platforms (Salmon, 2012)

ERT and its challenges:
- Technique & application
- Diagnosis & support
- No personal contact
- Reproduction tasks

(Aldon et al., 2021; Barlovits et al., 2021; Drijvers et al. 2021)

MCM

(Ludwig & Jablonski, 2021)

MCM@Home

(Barlovits et al., 2021)

ASYMPTOTE
- Complete distance learning
- "Blended Learning"
- Homework
- Exam preparation

(Barlovits et al, 2022)

The ASYMPTOTE concept

- ASYMPTOTE
  - Adaptive Synchronous Mathematics Learning Paths for Online Teaching in Europe
  - Erasmus+ project (DE, GR, IT, PT, ES)
- 2-component system
  - Goal: creation and editing of learning graphs (LG)
  - Web portal: creation of adaptive LG by teacher
  - App: differentiated & gamified use of LG by learners
- Synchronous handling of LG
  - Use & further development of the MathCityMap Digital Classroom

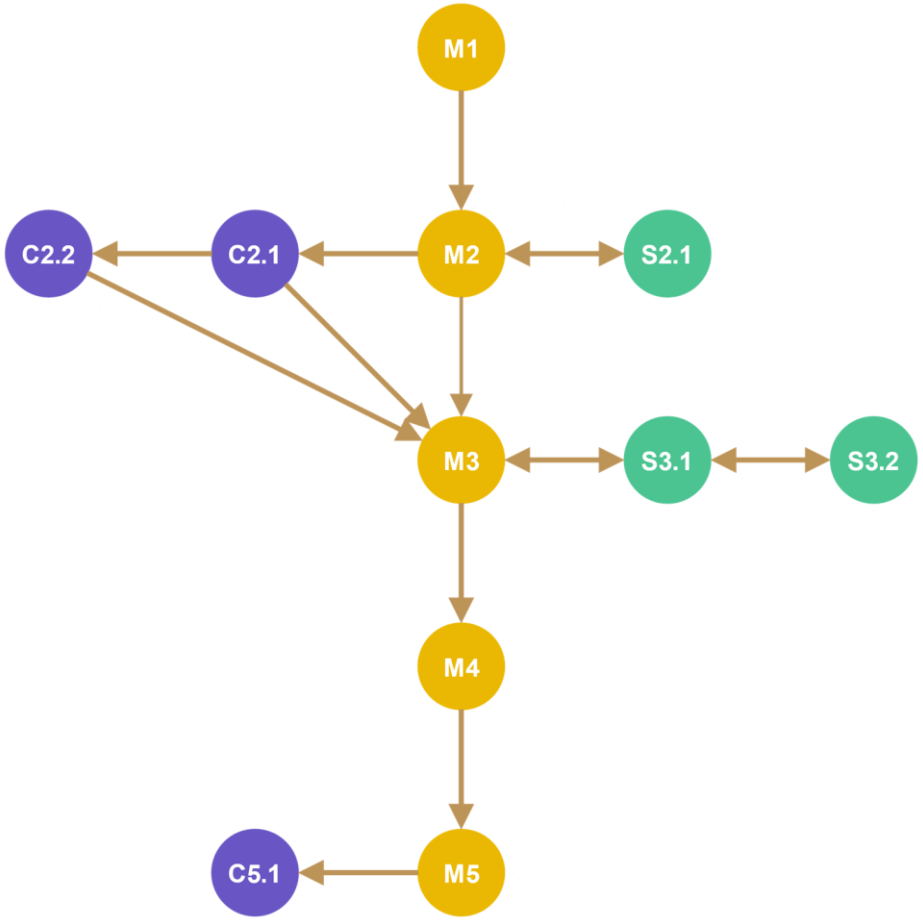
ASYMPTOTE
- Complete distance learning
- "Blended Learning"
- Homework
- Exam preparation

(Barlovits et al, 2022)

The ASYMPTOTE partners

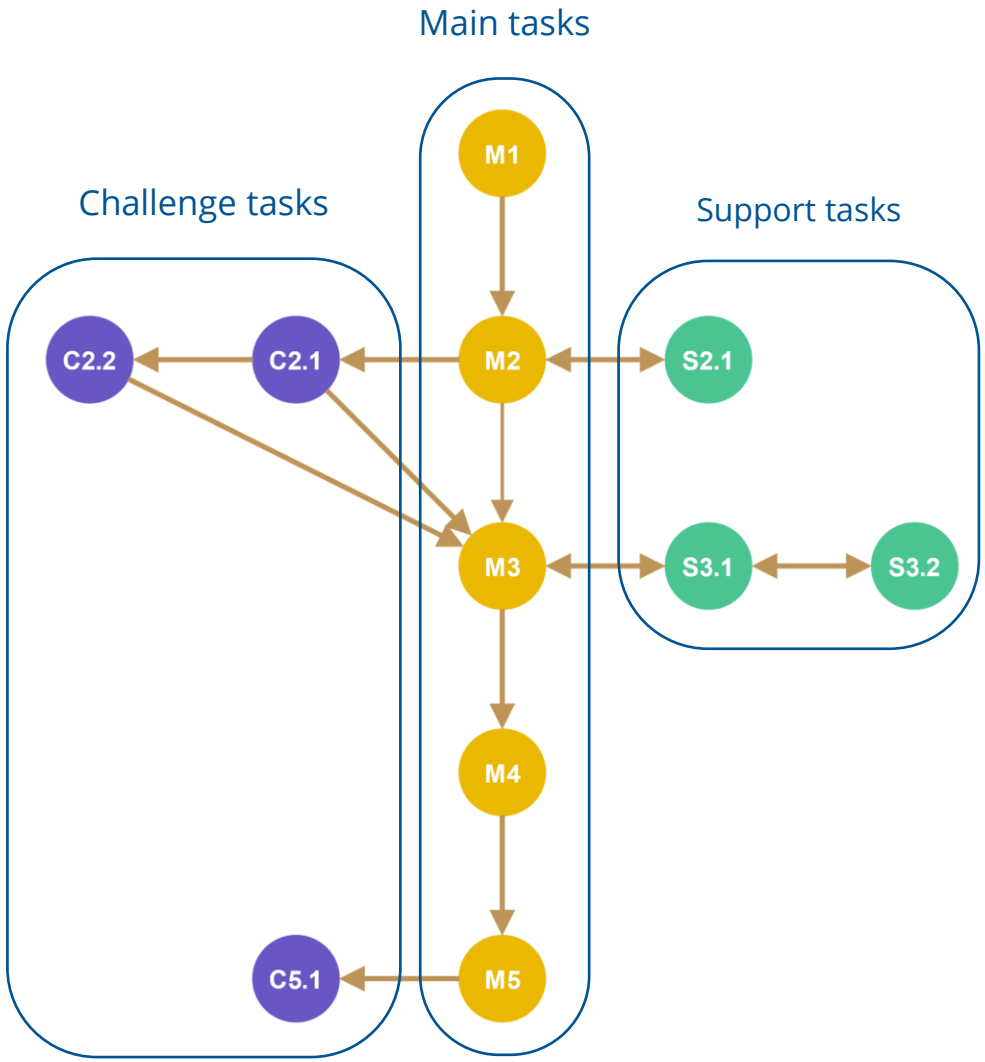
The Learning Graph concept

- Computer-based learning environments (Lichti & Roth, 2018; Greene et al., 2011):
  - Internet-based and pre-structured learning environment
  - Sequence of coordinated work assignments
  - Self-acting and self-responsible handling by learners
    → Enables choice of personal learning path
- ASYMPTOTE Learning Graph
  - Provision of a pre-structured learning environment
  - Learners can find their own way within the learning environment



The Learning Graph concept

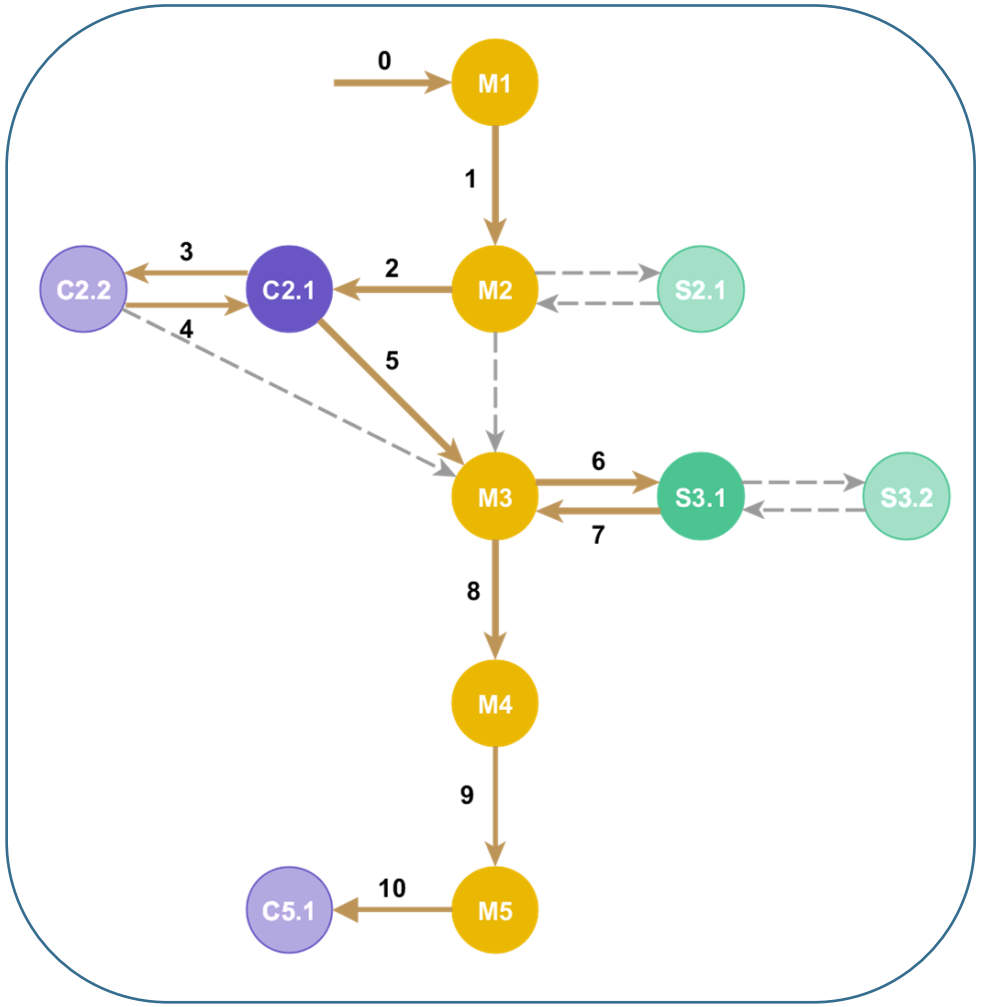
- Main tasks
  - Compulsory part
  - Goal: "Solve as many main tasks as possible!"
- Challenge tasks
  - Unlock by solving the previous task
  - Voluntarily accessible
- Support tasks
  - Voluntarily accessible
- Adaptivity & Autonomy
  - LG unfolds according to work progress & performance level
  - At the same time, the idea of freedom of choice is preserved



The Learning Graph concept

- Main tasks
  - Compulsory part
  - Goal: "Solve as many main tasks as possible!"
- Challenge tasks
  - Unlock by solving the previous task
  - Voluntarily accessible
- Support tasks
  - Voluntarily accessible
- Adaptivity & Autonomy
  - LG unfolds according to work progress & performance level
  - At the same time, the idea of freedom of choice is preserved

Example of an individual learning path

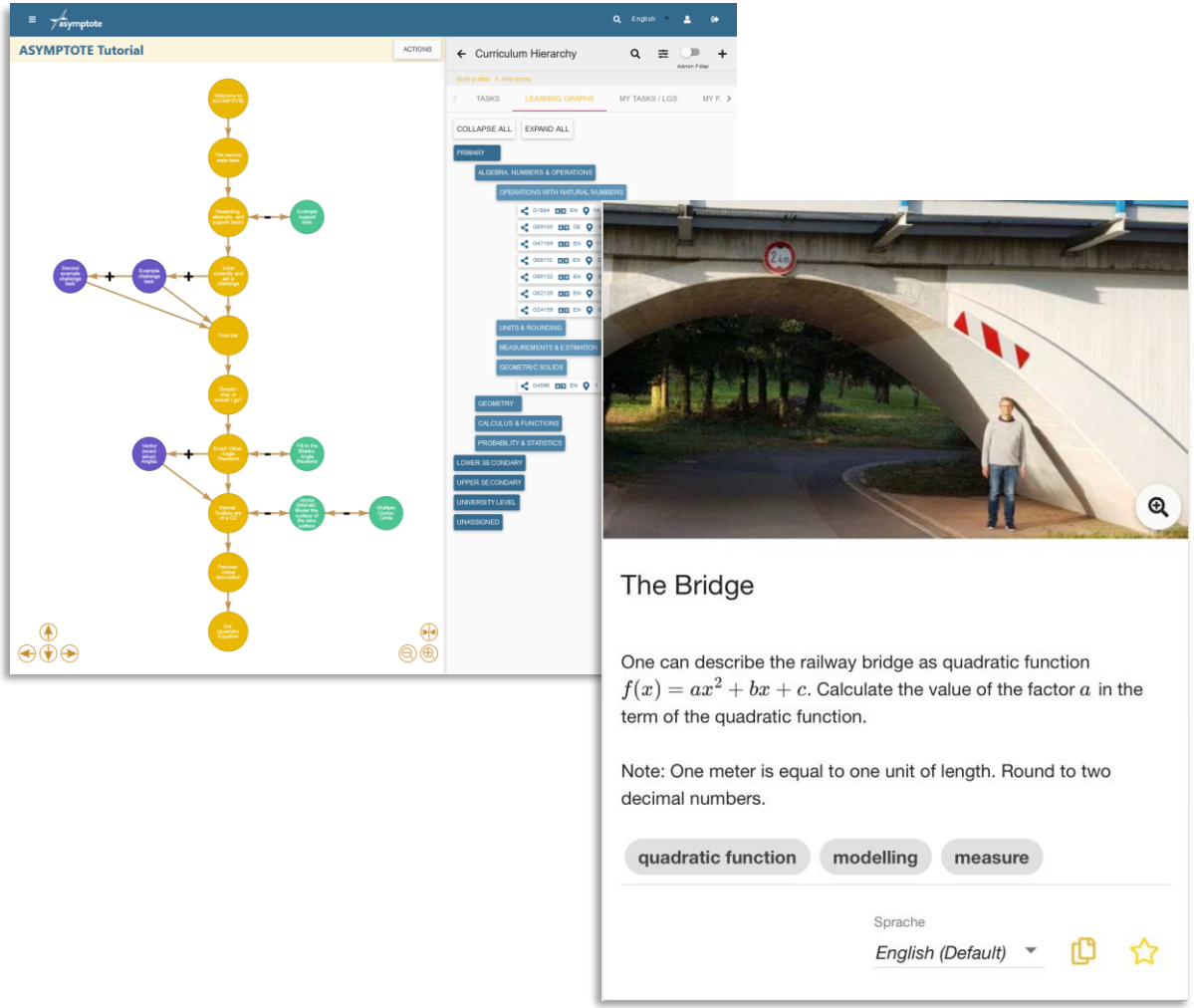


Introduction to ASYMPTOTE

4.2 Key Functionalities of ASYMPTOTE

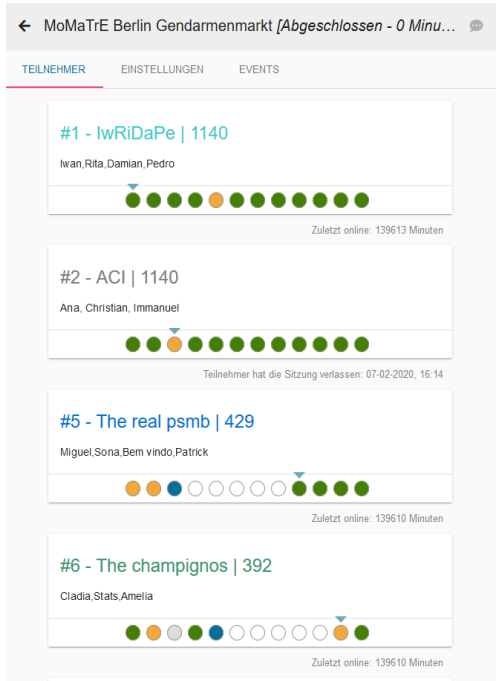
The web portal

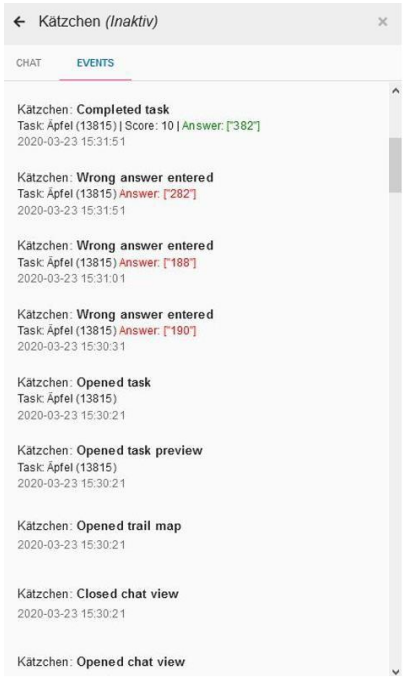
- Workspace of the teacher
- Selection & creation of tasks
  - 9 task formats, including exact value, multiple choice, fill-in-the-blank, ...
- Learning Graph selection & creation
- Community platform
  - Share & publish content you create
- Digital classroom

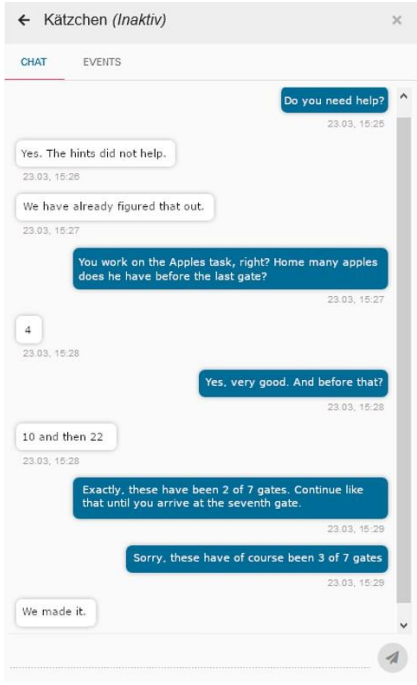


The Digital Classroom

- Features
  - Class overview
  - Evaluation function
  - Communication function
- Update 2023
  - Digital classroom as a representation of the class unit
    → Handling of multiple LG possible
  - Advanced analyses for each LG
  - Long-term analyses by comparing multiple LGs within a Digital Classroom

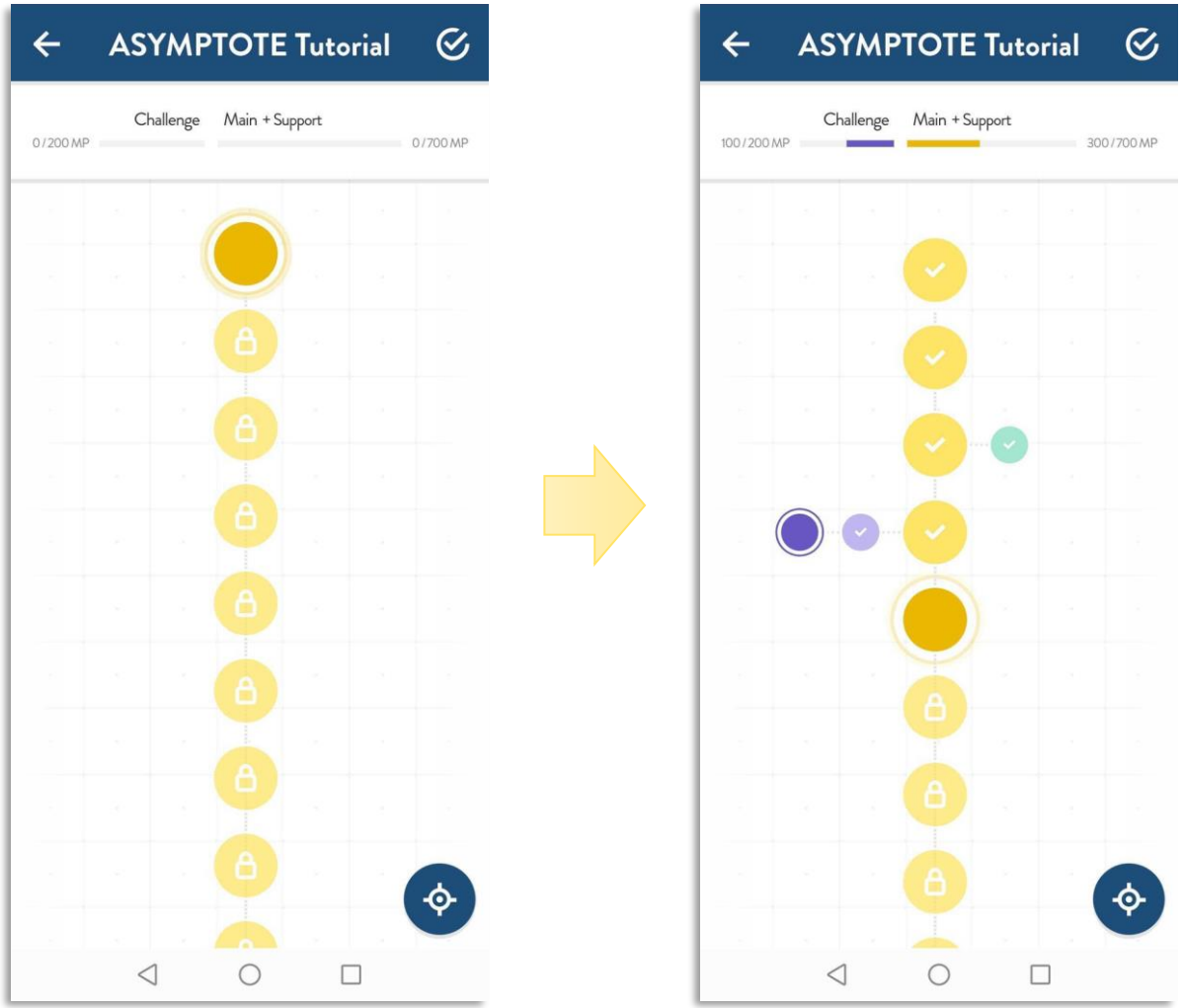






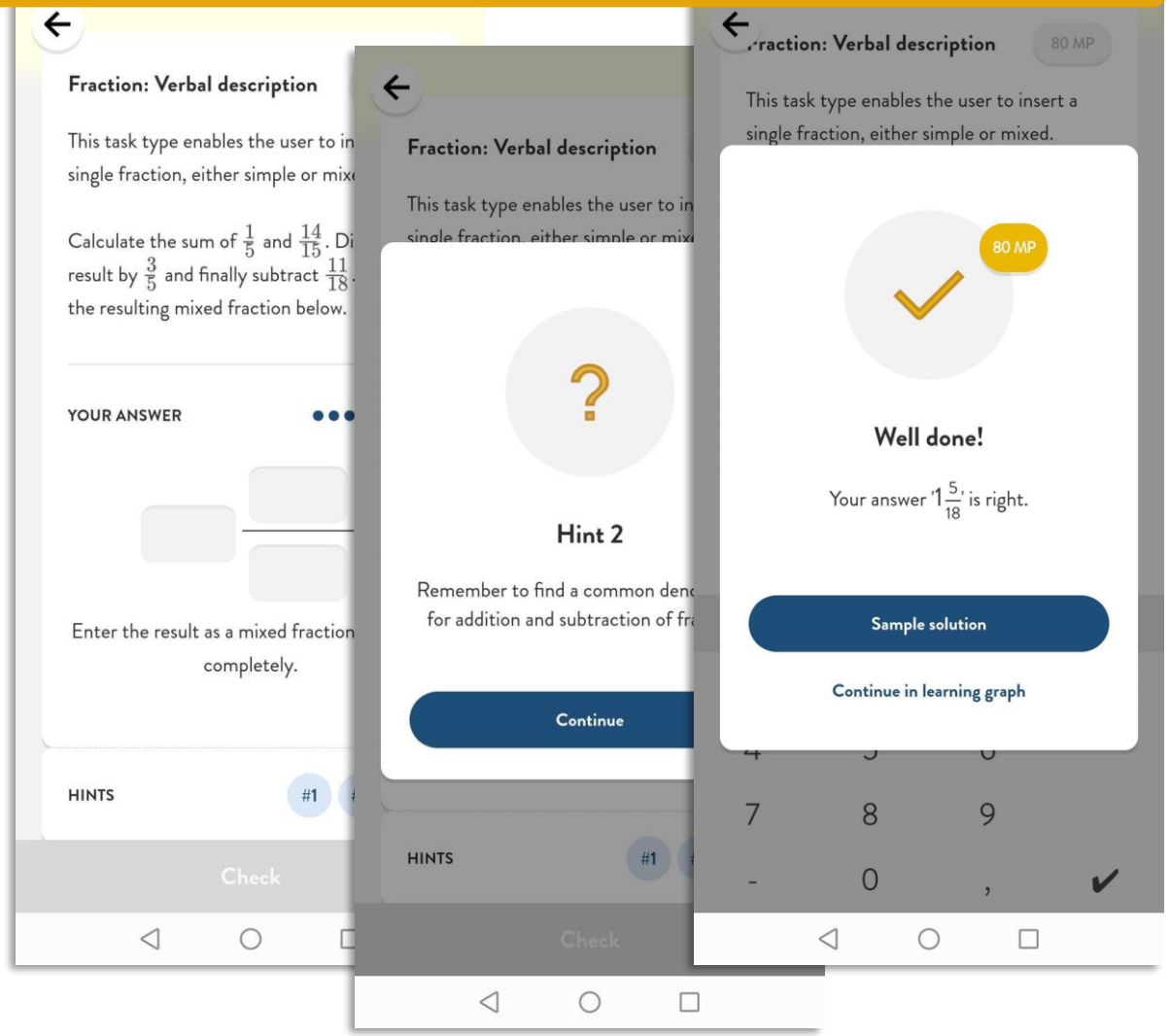
The app

- Workspace of the learner
- No registration necessary
  - Accessing an LG or Digital Classroom by code
- Working on a Learning Graph
  - Gamification: points
  - Can be interrupted and continued later
  - Several times possible



The app

- 4 answer attempts per task
  - of which 1 free attempt
- Stepped hints
- Answer validation
- Sample solutions



ASYMPTOTE Tutorial LG:

Try out the app from the student perspective by entering the code **g47109** in the app

The ASYMPTOTE App

5. How to use the ASYMPTOTE App

Application download

For **Android**:

1. Visit Google play
2. Search for “ASYMPTOTE”
3. Click on the download button

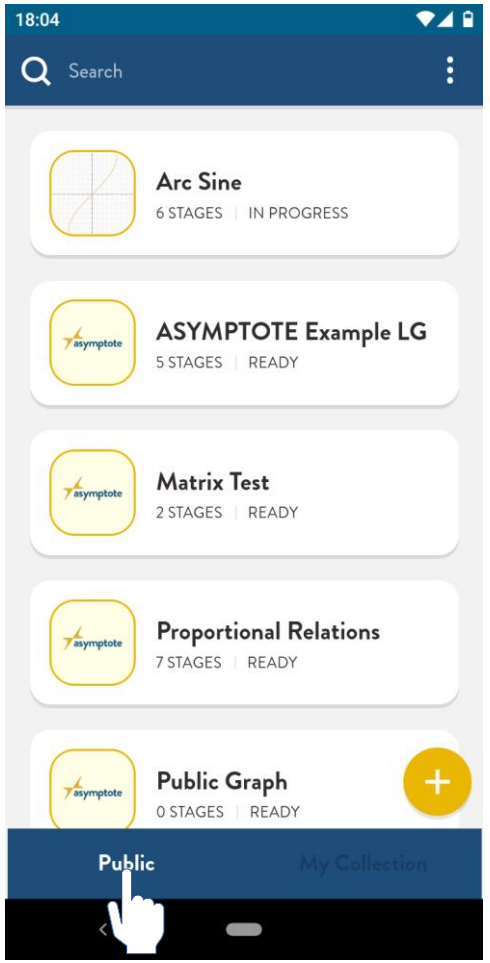
For **iOS**:

1. Visit AppStore
2. Search for “ASYMPTOTE”
3. Click on the download button

Application Functionalities

The ASYMPTOTE App offers the possibility …

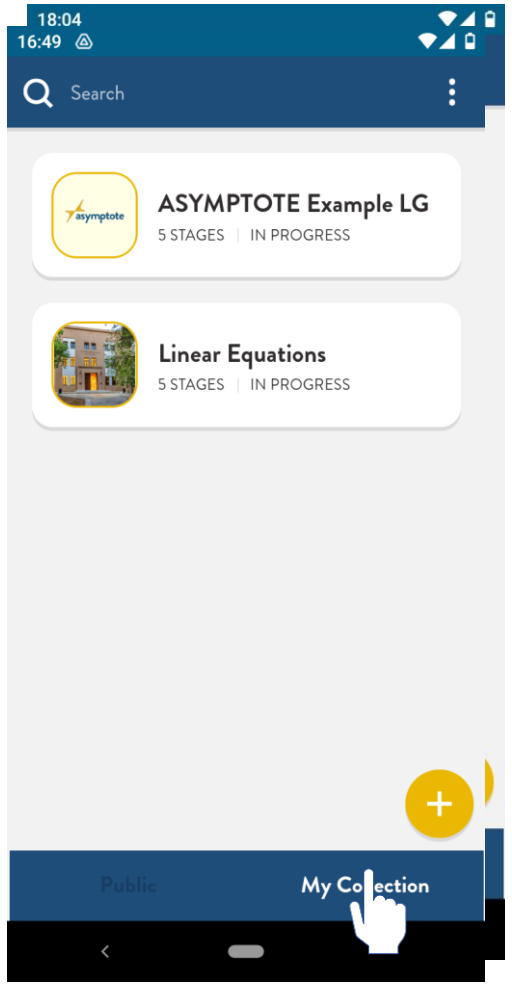
1. to select a **public Learning Graph** from a list available



Application Functionalities

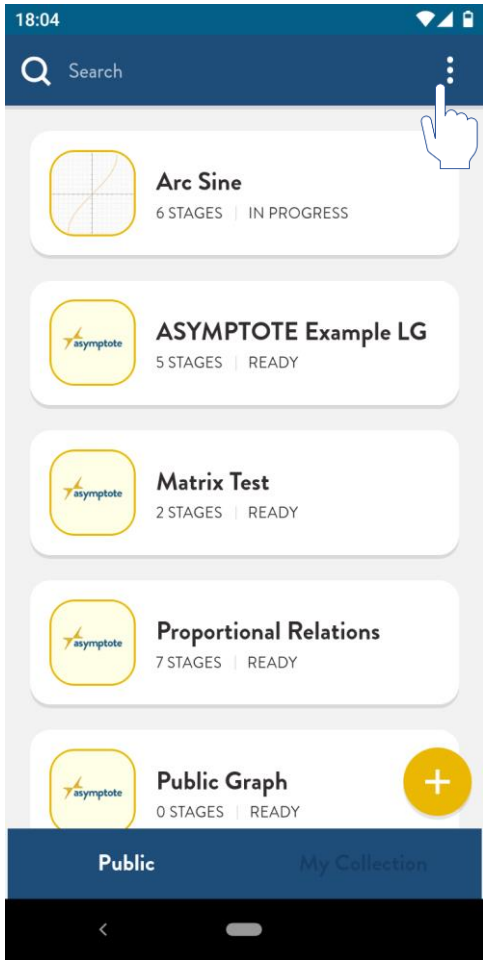
The ASYMPTOTE App offers the possibility …

1. to select a **public Learning Graph** from a list available
2. to form a personal gallery of **Learning Graphs** in **“My collection”**



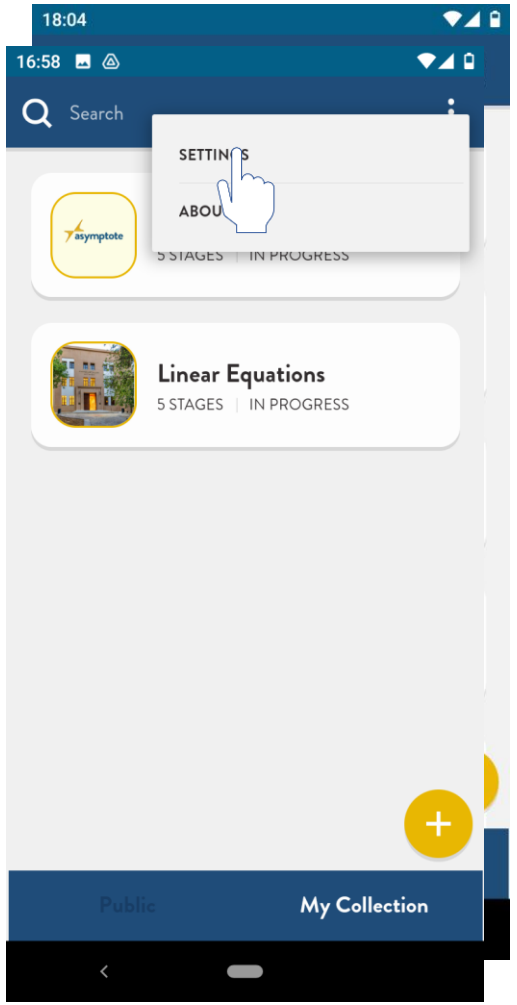
Before you start

1. **Select the language you prefer**
   - Click on the **three dots** button



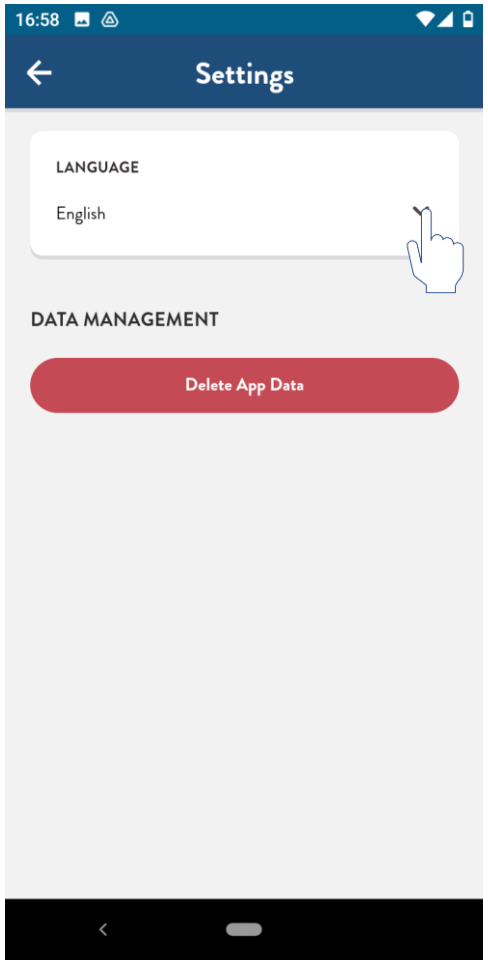
Before you start

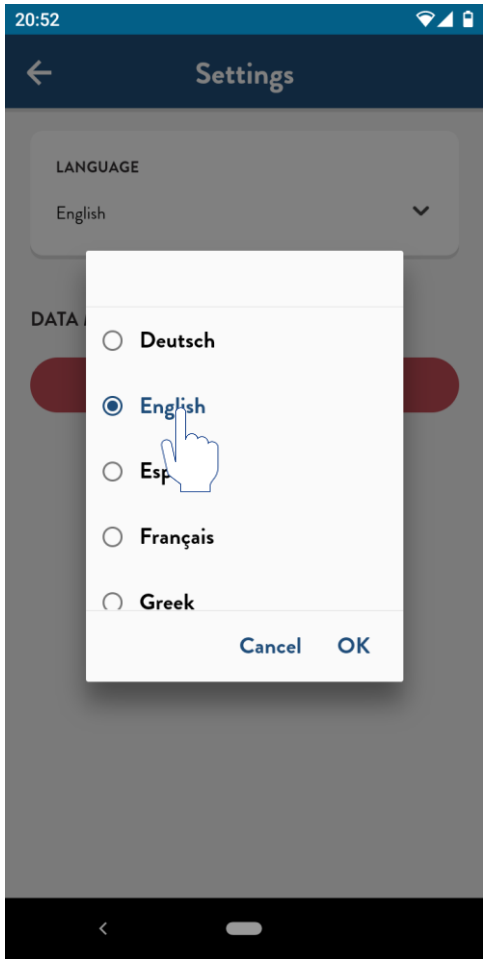
1. **Select the language you prefer**
   - Click on the **three dots** button
   - Click on “**SETTINGS**”



Before you start

1. **Select the language you prefer**
   - Click on the **three dots** button
   - Click on “**SETTINGS**”
   - Select your language

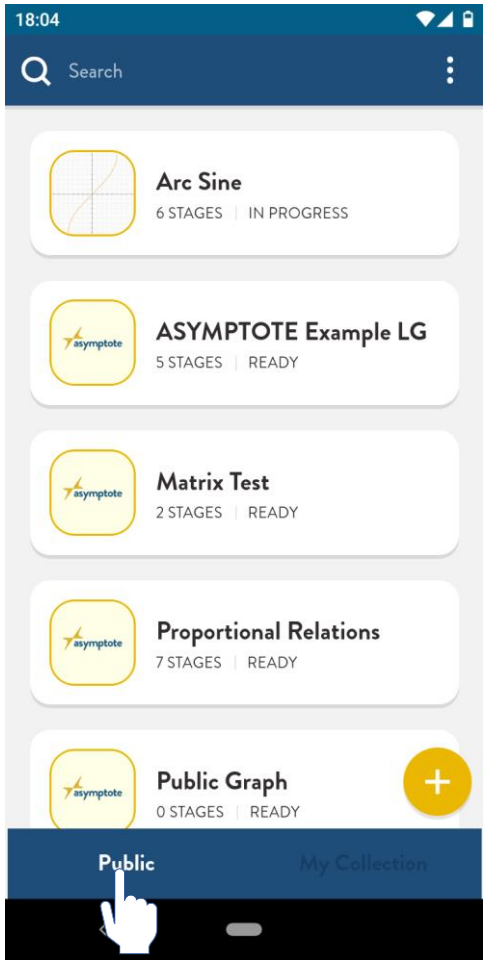




Select a public Learning Graph

1. Click on the “**Public**" button down on the left
2. Choose a Learning Graph from the available list

✓ To search the list by name or code for a desired Learning Graph you can use the **search** button

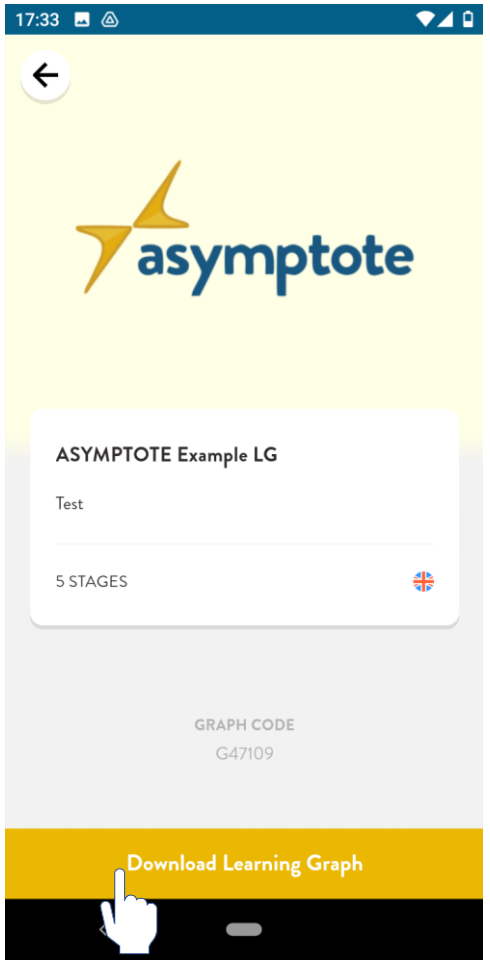


Select a public Learning Graph

1. Click on the “**Public**" button down on the left
2. Choose a Learning Graph from the available list

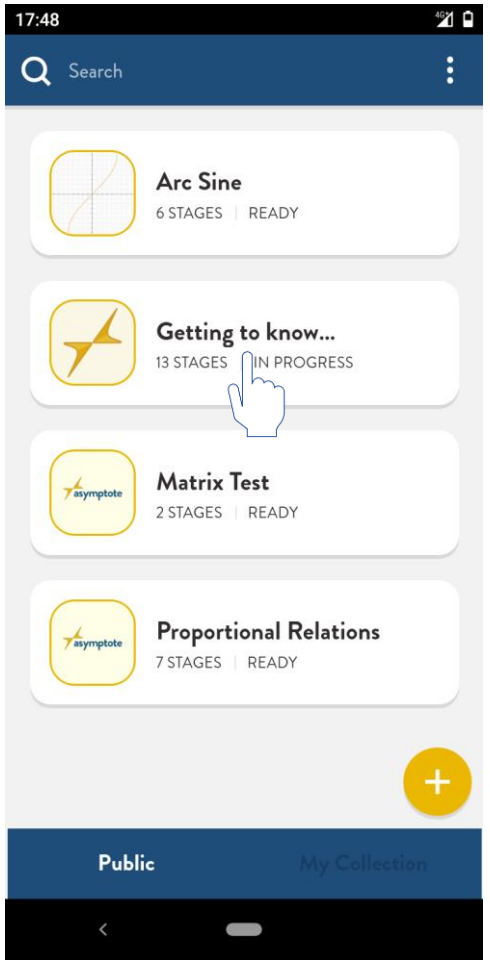
✓ To search the list by name or code for a desired Learning Graph you can use the **search** button

3. Download the desired Learning Graph



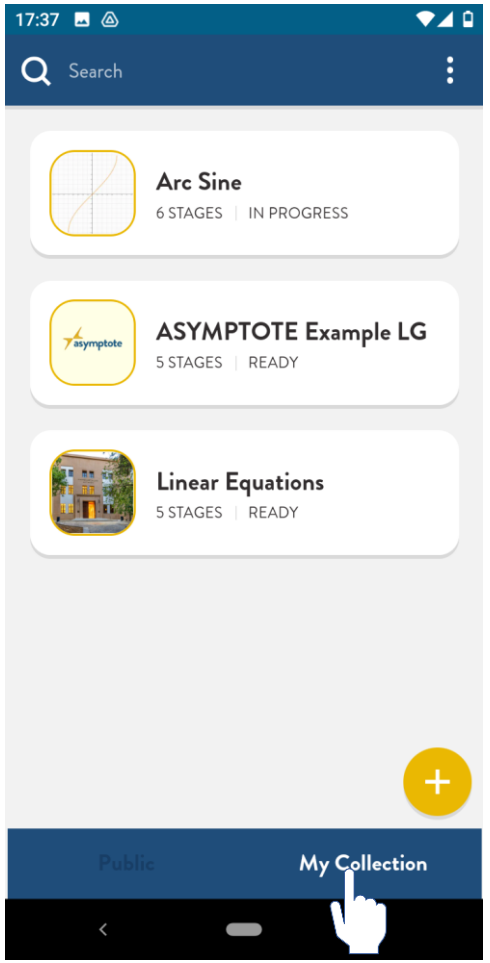
Getting to know ASYMPTOTE app

1. **Before you start** exploring the app by yourself it is recommended to choose the **Getting to know ASYMPTOTE** Learning Graph
2. This Learning Graph **presents the features** of the ASYMPTOTE app and **the multiple answer formats**.
3. You can also search this Learning Graph by code: **G47109**



“My Collection” of Learning Graphs

1. Every downloaded Learning Graph is automatically added to your personal gallery “**My Collection**”
2. To **add** any desired Learning Graph to “My Collection” click on the + button (search by code)
3. You can also **remove** any Learning Graph that you don’t need anymore from your collection



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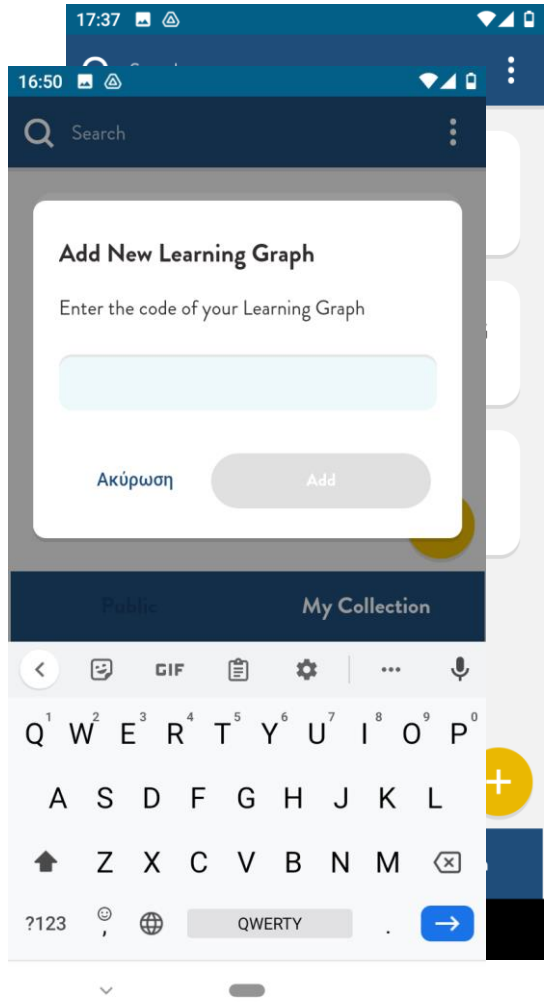

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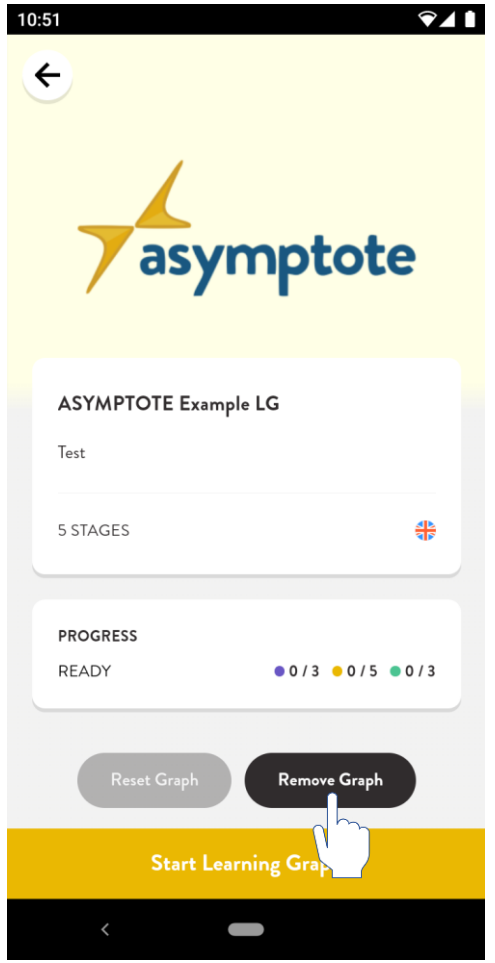
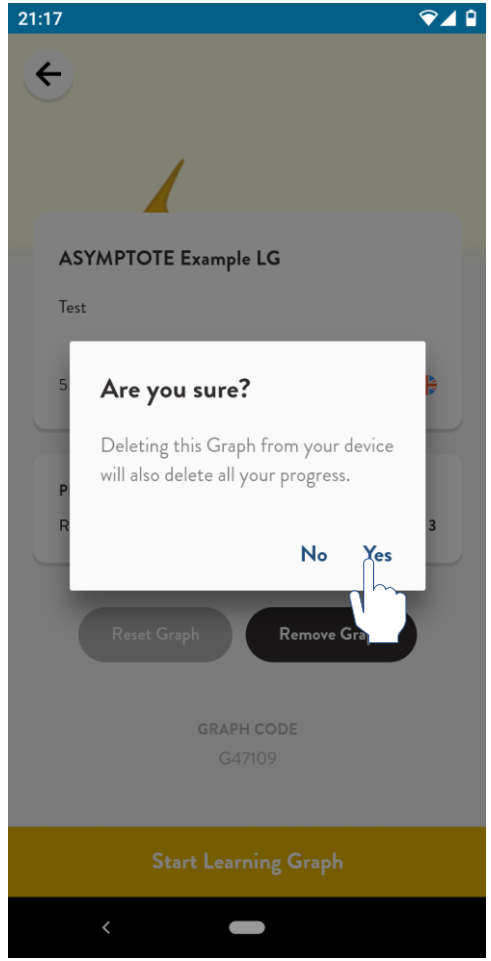
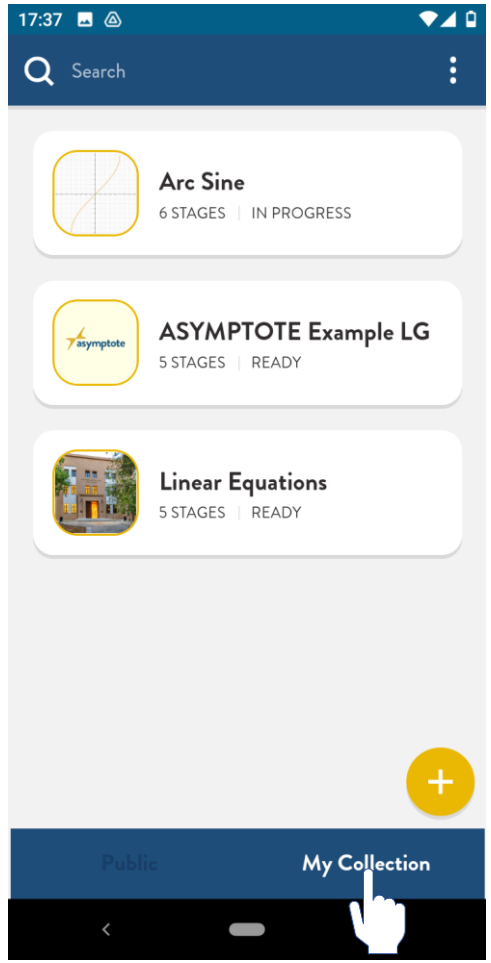




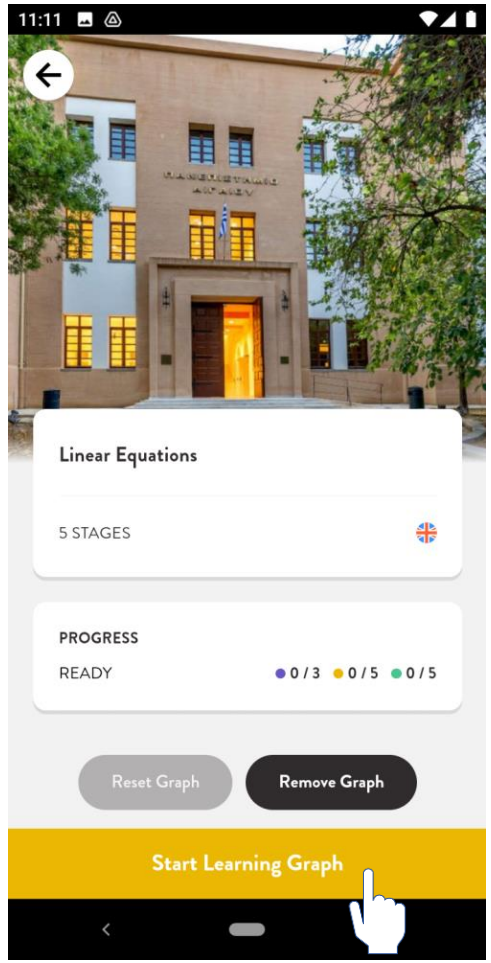
Start Learning Graph

1. Choose a Learning Graph from ”**My Collection**”



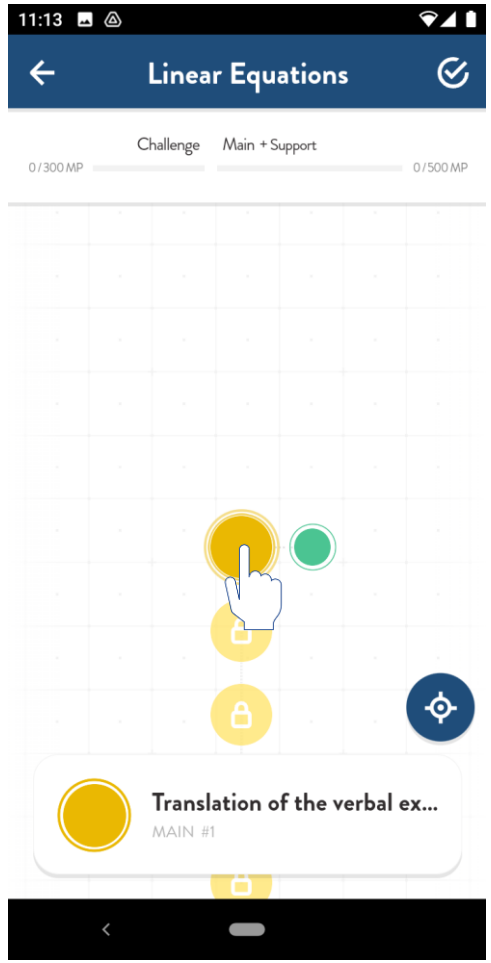
Start Learning Graph

1. Choose a Learning Graph from ”**My Collection**”
2. Click on the “**Start Learning Graph**" button down bellow



Start Learning Graph

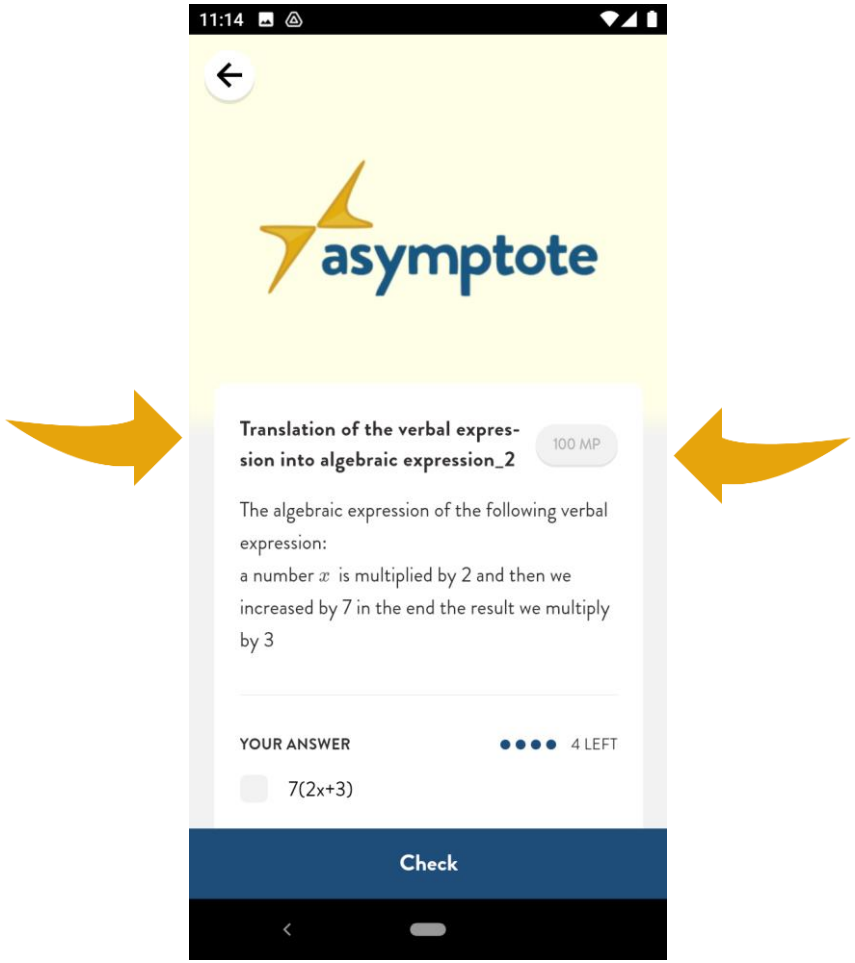
1. Choose a Learning Graph from ”**My Collection**”
2. Click on the “**Start Learning Graph**" button down bellow
3. Click on the **main task** (orange) or the **support task** (green) to start solving



The task formular

On this interface you can see:

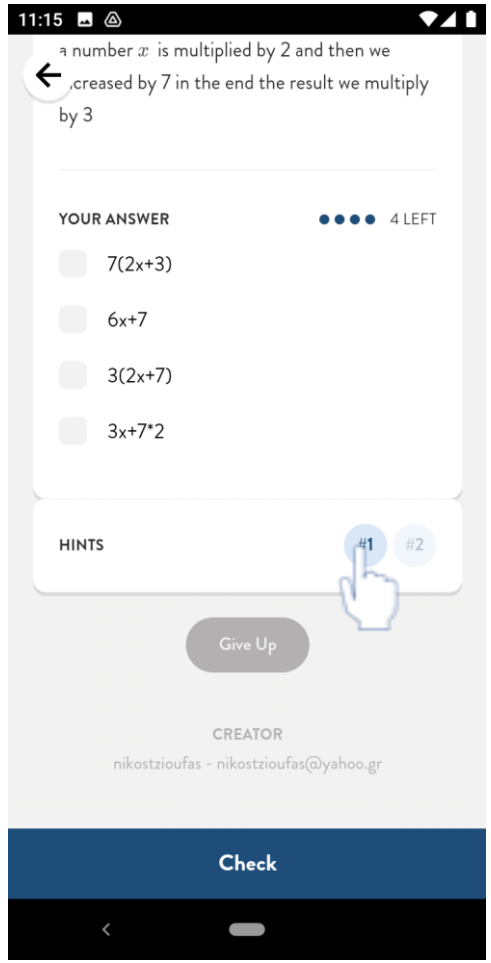
- The task **title**
- The task **definition**
- The **answer area**
- The task **points**
- How many **tries** you have left



The task formular

Scrolling down on this interface you can see:

- The available **Hints**
- The “**Give up”** button

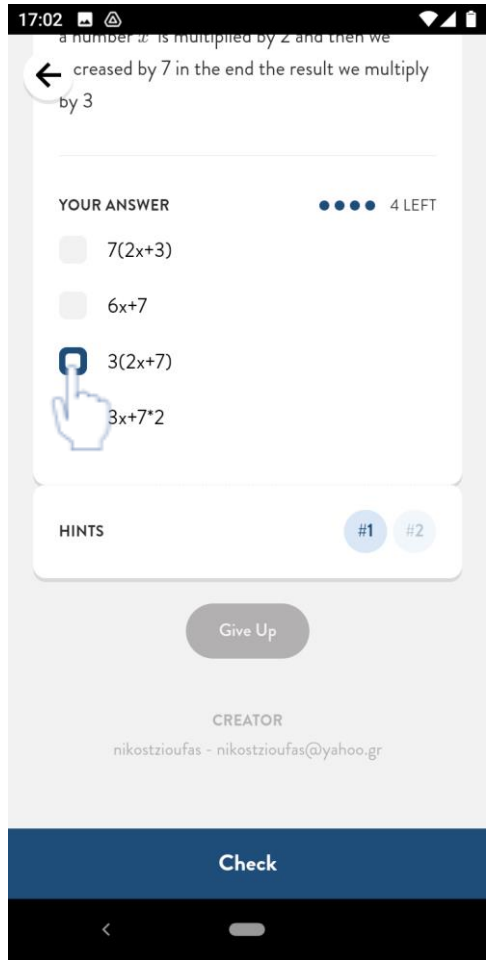


Answering the task

Choose an answer

1. If it is **correct**:

- You can see the **Sample solution** and you can **Continue**



Answering the task

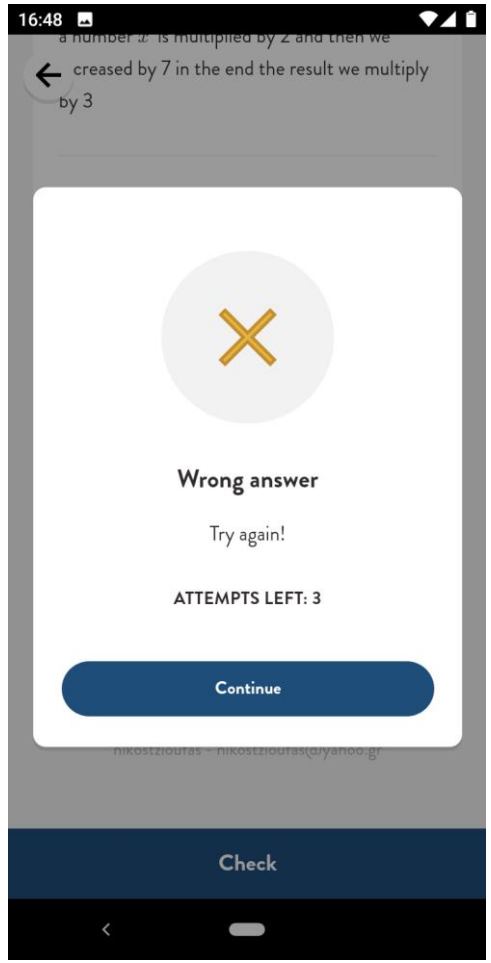
Choose an answer

1. If it is **correct**:

- You can see the **Sample solution** and you can **Continue**

2. If it is **wrong**:

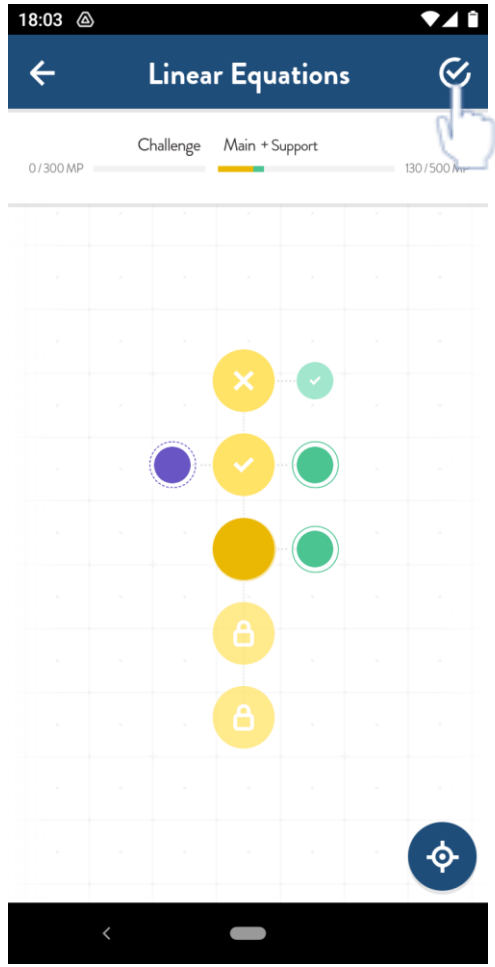
- The first time **you don't get any help**
- The second and third time **a Hint is suggested** by the system
- The fourth time the **sample solution is available**
  - Then you should **return to the Learning Graph** to continue



The System suggest to use support / challenge tasks after twice failing / solving a task

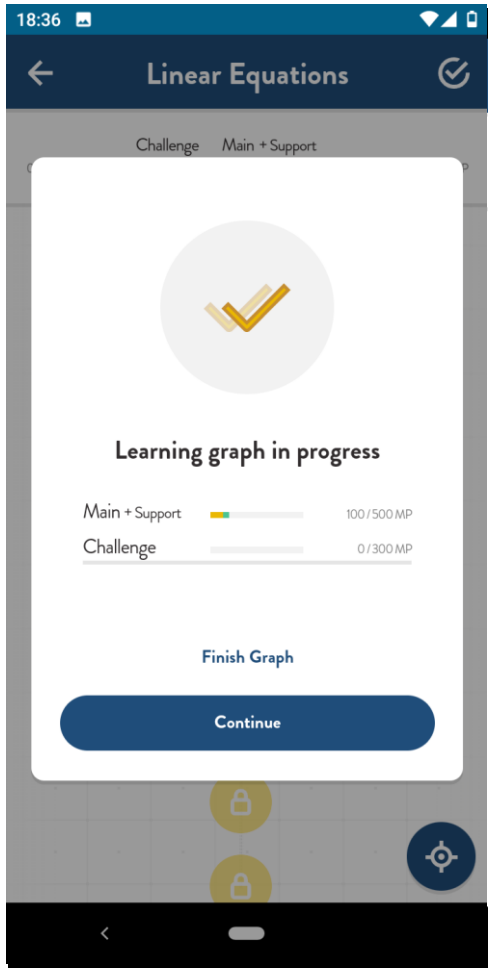
Other options

1. You can check the progress of a Learning Graph on the **top side of the screen**



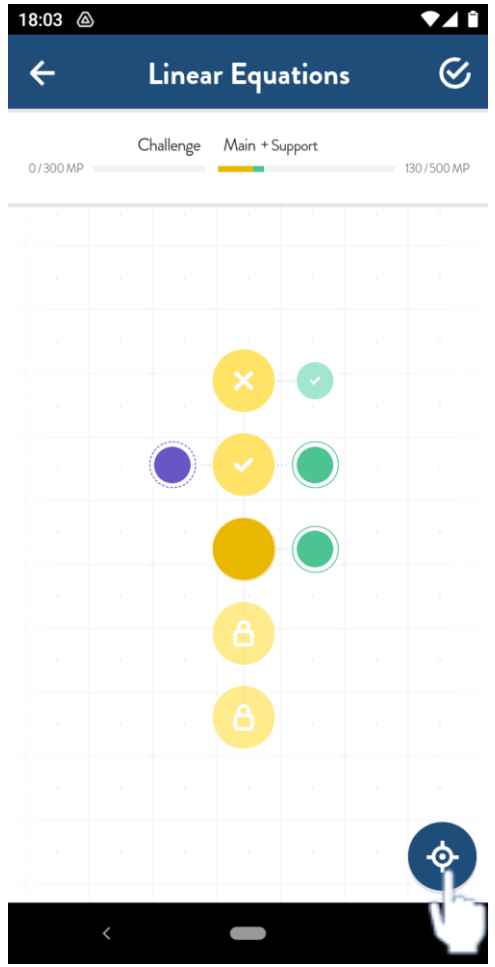
Other options

1. You can check the progress of a Learning Graph on the **top side of the screen**
2. You can also check the progress and/or finish a Learning Graph using the **check** button



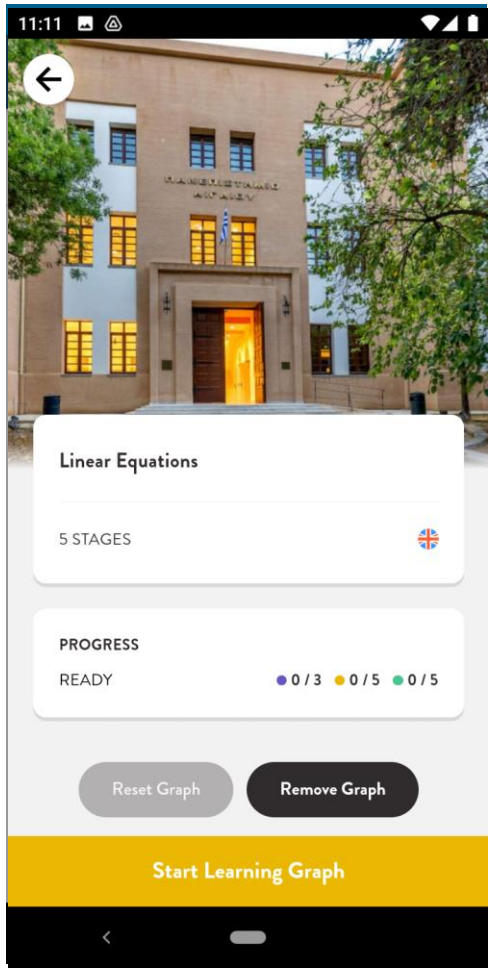
Other options

1. You can check the progress of a Learning Graph on the **top side of the screen**
2. You can also check the progress and/or finish a Learning Graph using the **check** button
3. With the **target** button you can bring back the Learning Graph in the center of the screen



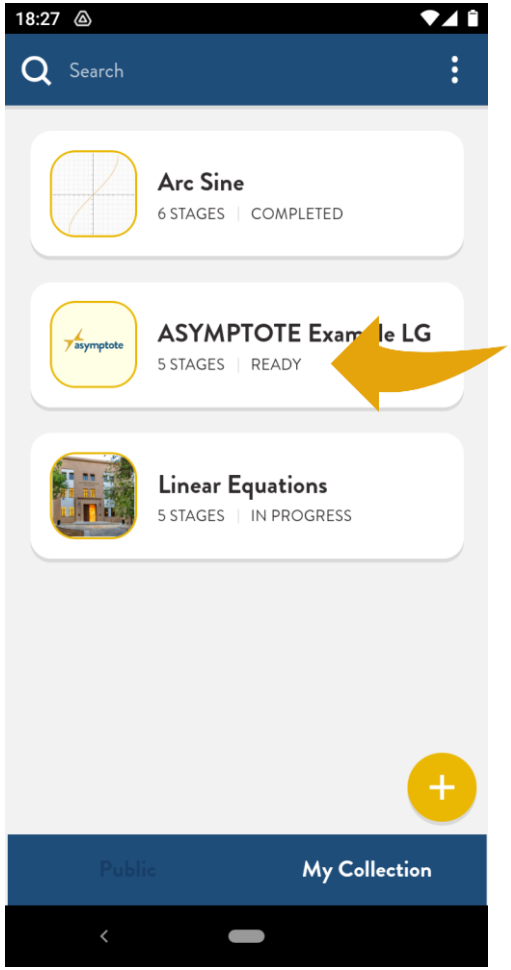
Other options

1. You can check the progress of a Learning Graph on the **top side of the screen**
2. You can also check the progress and/or finish a Learning Graph using the **check** button
3. With the **target** button you can bring back the Learning Graph in the center of the screen
4. You can exit the Learning Graph for a while using the **arrow** button



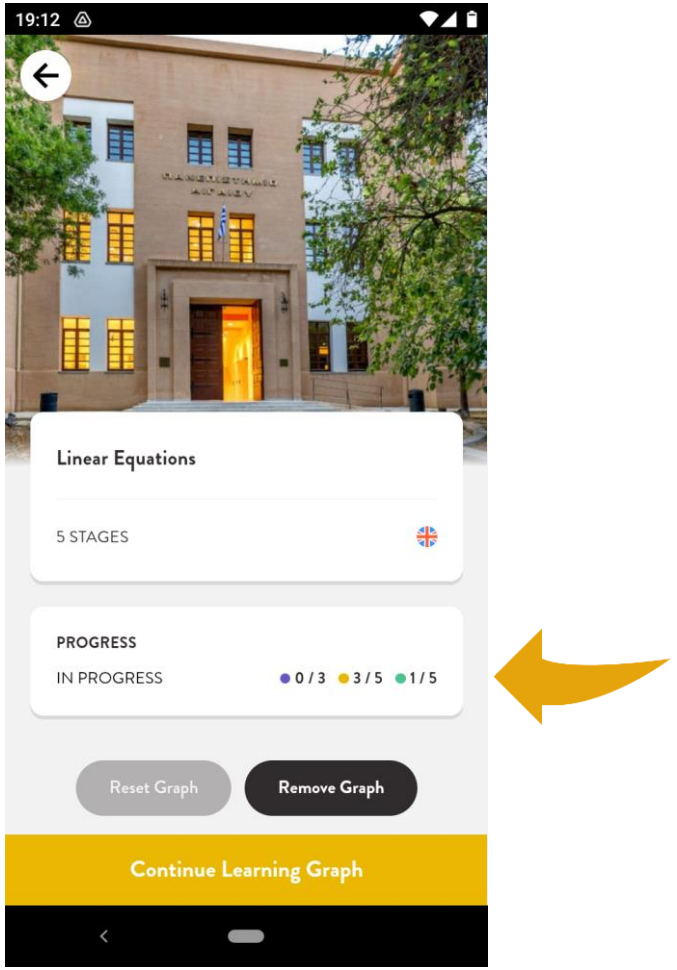
Other options

1. The Learning Graphs that you haven't started yet are marked with the indication "**READY**"



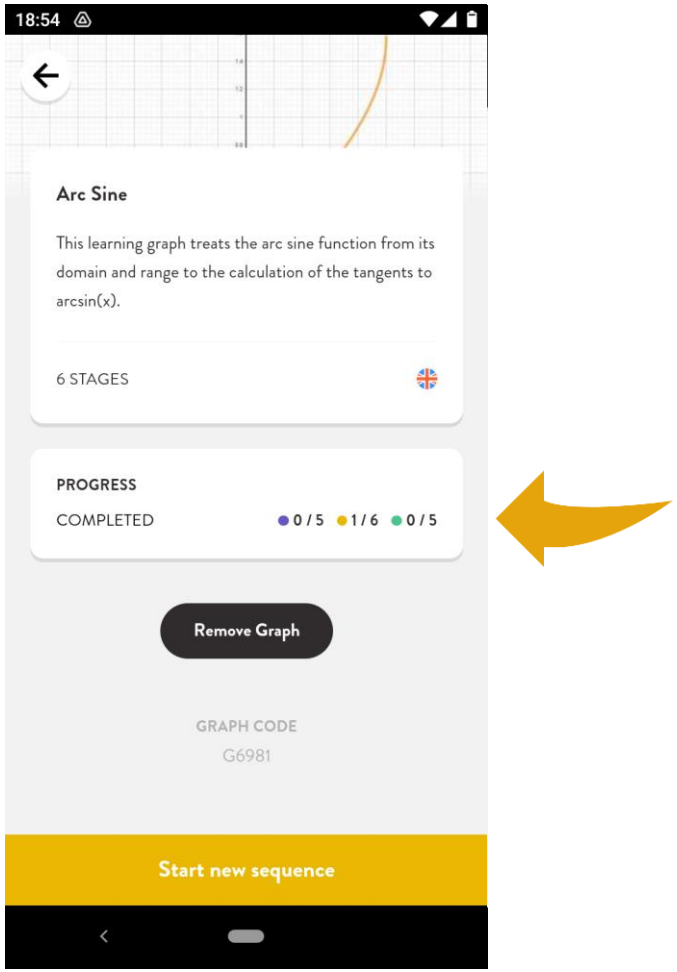
Other options

1. The Learning Graphs that you haven't started yet are marked with the indication "**READY**"
2. The unfinished Learning Graphs are marked with the indication "**IN PROGRESS**"
   - You can **reset** every unfinished Learning Graph to start again from the beginning



Other options

1. The Learning Graphs that you haven't started yet are marked with the indication "**READY**"
2. The unfinished Learning Graphs are marked with the indication "**IN PROGRESS**"
   - You can **reset** every unfinished Learning Graph to start again from the beginning
3. The finished Learning Graphs are marked with the indication "**COMPLETED**"
   - you can also **start a new sequence** of the finished Learning Graphs
   - or you can **Remove Graph** download it again and make a fresh start



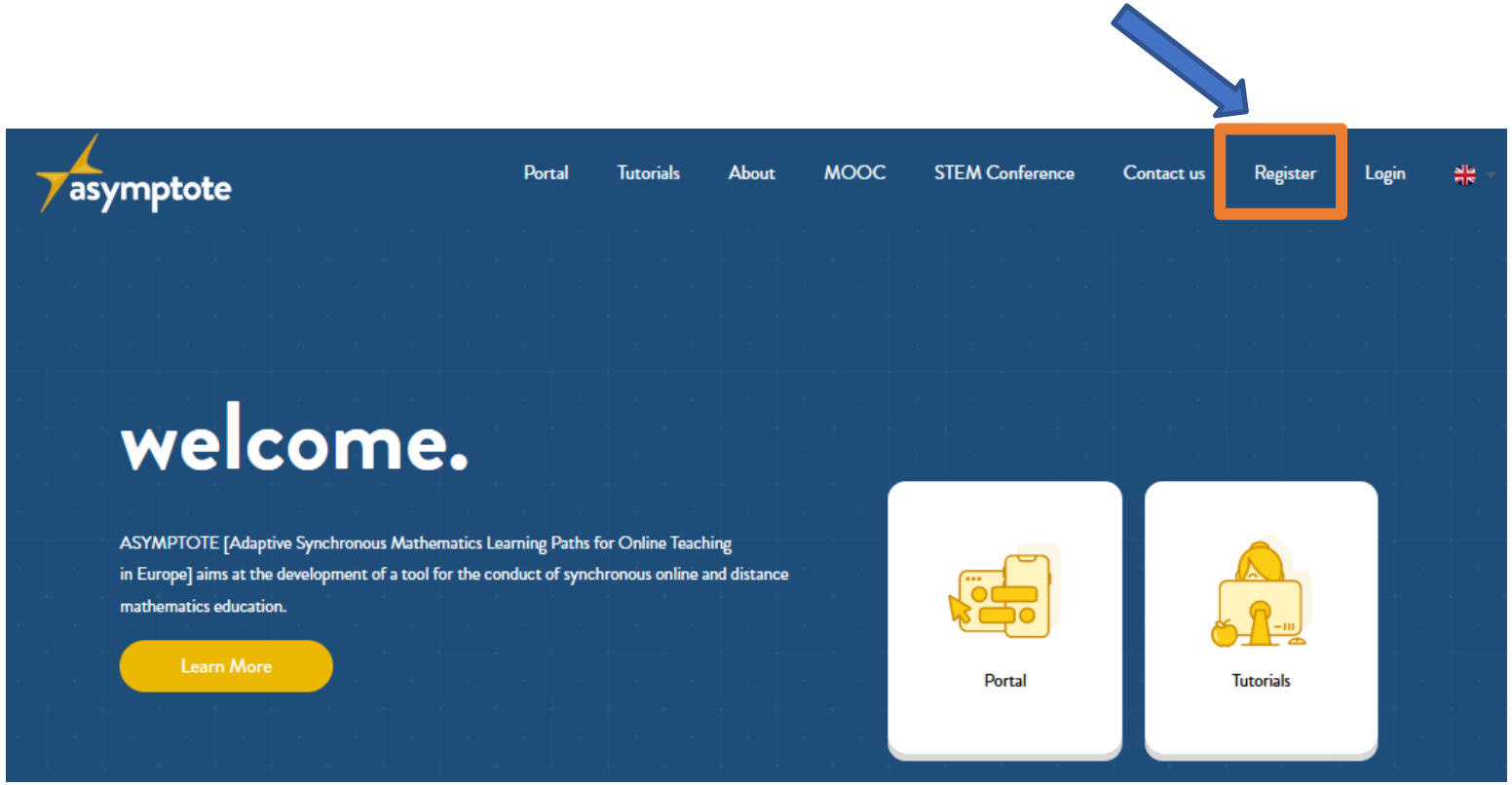
ASYMPTOTE Web Portal

6.1 Registration

Web Portal Registration

Visit the ASYMPTOTE Web Portal: https://www.asymptote-project.eu/en/welcome/

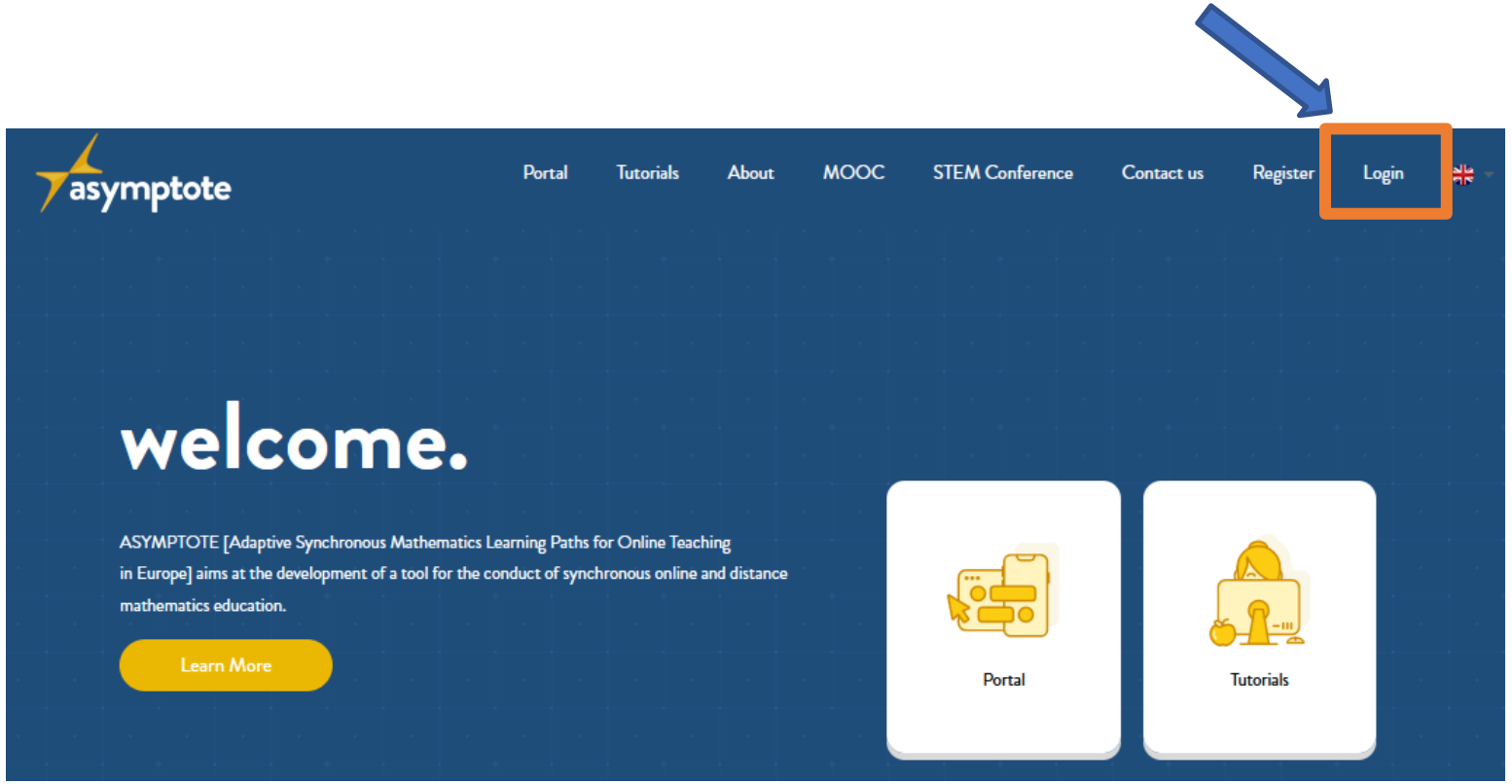
1. Click on the “Register” button
2. Fill out the registration form



Web Portal Login

Visit the ASYMPTOTE Web Portal: https://www.asymptote-project.eu/en/welcome/

1. Click on the “Login” button and enter your username and password
2. Click on the “Portal” button



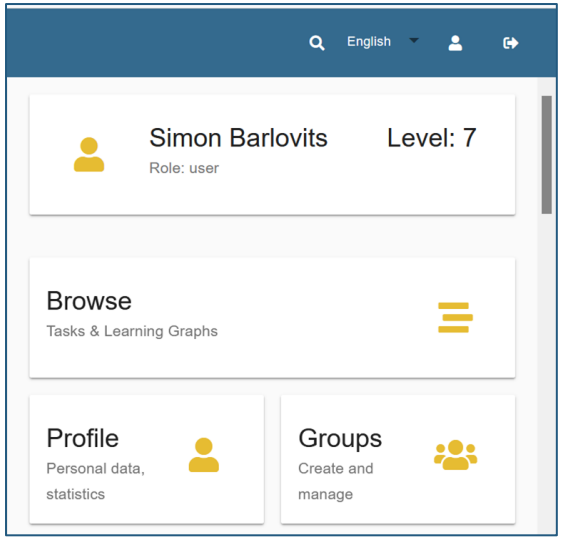
ASYMPTOTE Web Portal

6.2 Selection of Tasks

Web Portal Functionalities

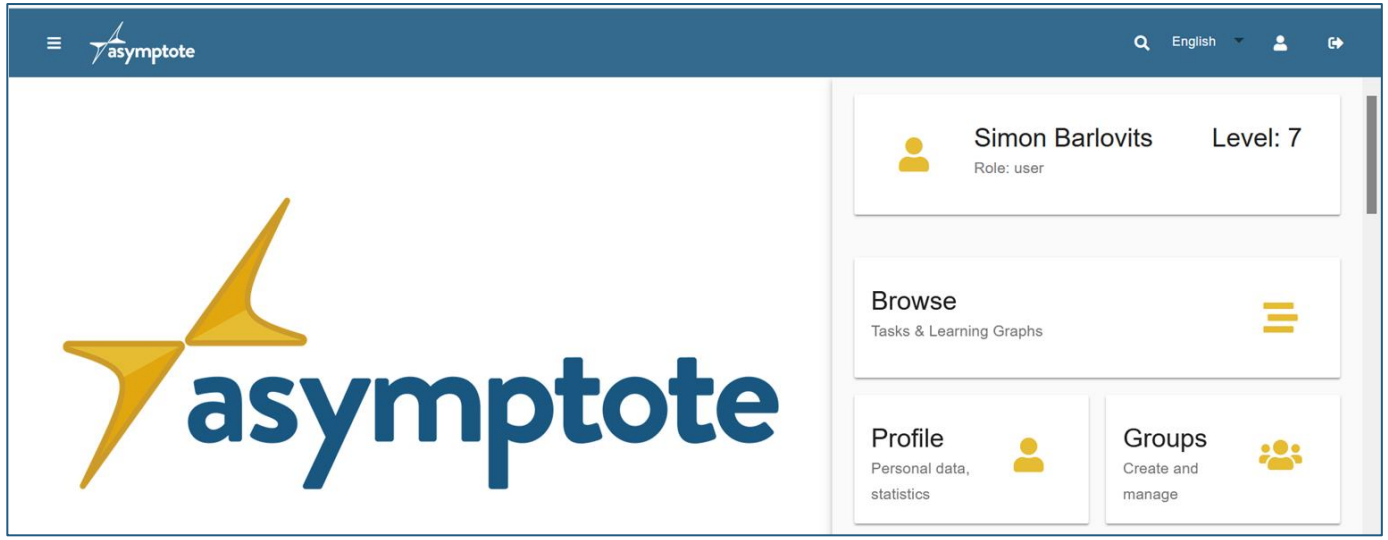
The ASYMPTOTE Web Portal offers the possibility …

1. **to select digital tasks** and adaptive learning graphs **from an open database**
2. to create own tasks and learning graphs
3. to make own tasks and learning graphs available to other users
   - by sharing own tasks and learning graphs with groups
   - by making them publicly available for all users
4. to monitor student's working progress in the Digital Classroom



Selection of Tasks

1. Click on the “Browse” button
2. Search in the “Hierarchy” for the topic of your choice:
   - All tasks are marked in the hierarchy
   - The hierarchy is structured by level & curricular topics
   - You can filter for task languages
   - The task preview shows the code of the task, its language & title
3. Select and open a task



Selection of Tasks

1. Click on the “Browse” button
2. Search in the “Hierarchy” for the topic of your choice:
   - All tasks are marked in the hierarchy
   - The hierarchy is structured by level & curricular topics
   - You can filter for task languages
   - The task preview shows the code of the task, its language & title
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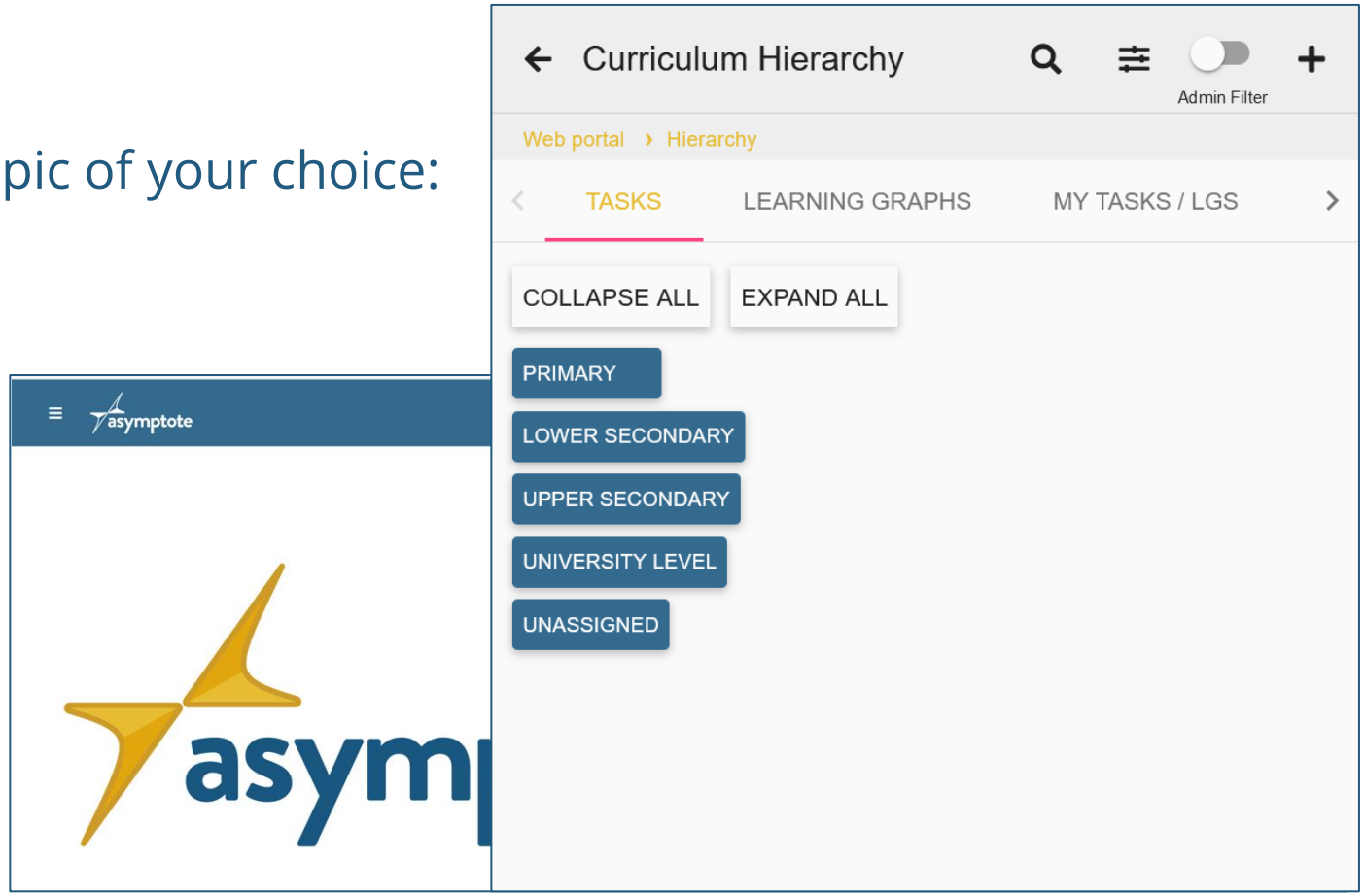

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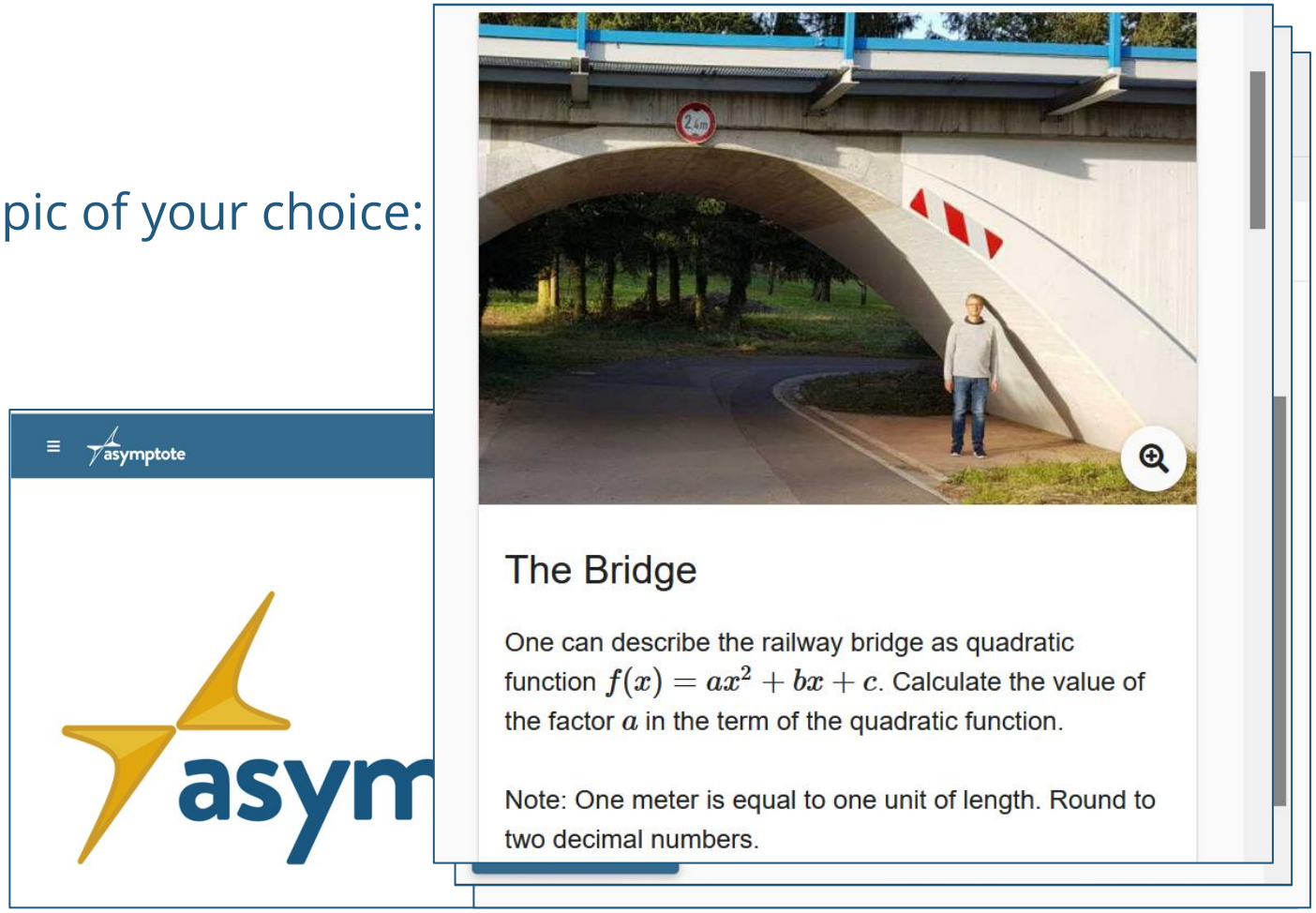

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   - All tasks are marked in the hierarchy
   - The hierarchy is structured by level & curricular topics
   - You can filter for task languages
   - The task preview shows the code of the task, its language & title
3. Select and open a task

As practice, please invoke the task “The bridge”.

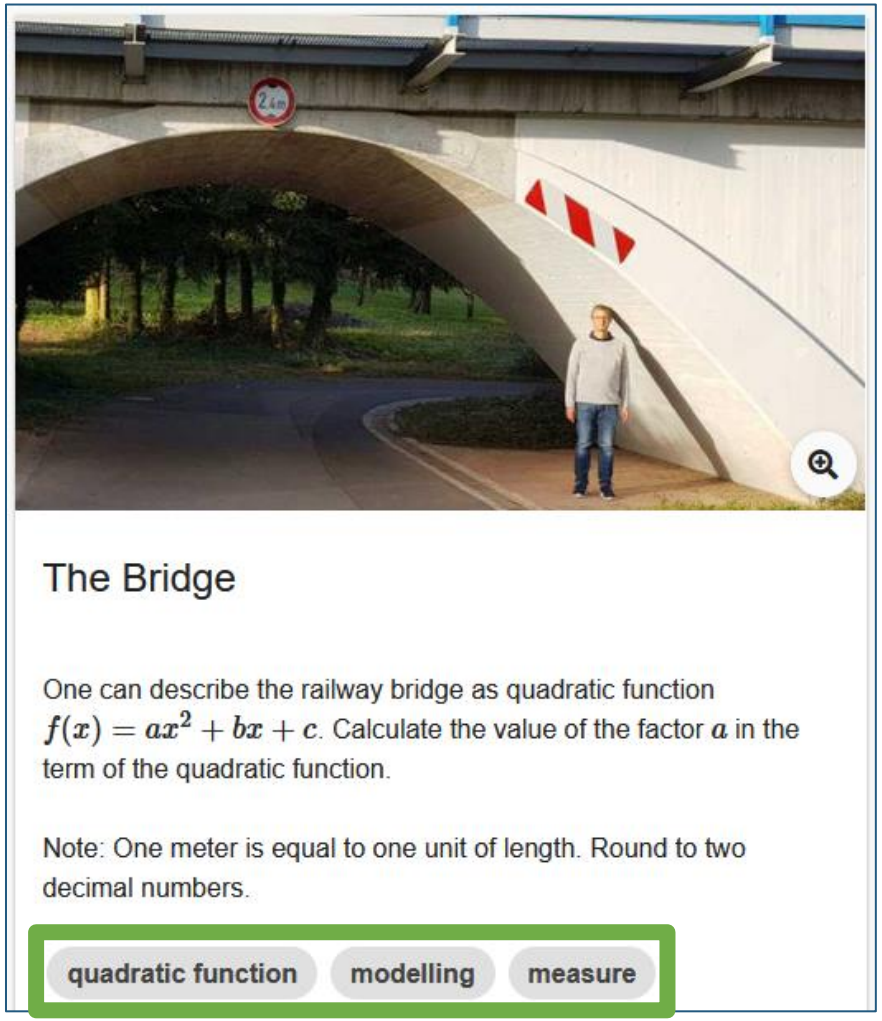
It is a task on lower secondary level treating quadratic functions

The Task Formular

As an example, please invoke the task “The bridge” (Link)

A task consists of:

1. Title & task instruction
2. Picture (optional)
3. Curriculum hierarchy
4. Task category: learning/training/modeling/reasoning
5. Answer format
6. Stepped hints
7. Grade & Tags



The Task Formular

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A task consists of:

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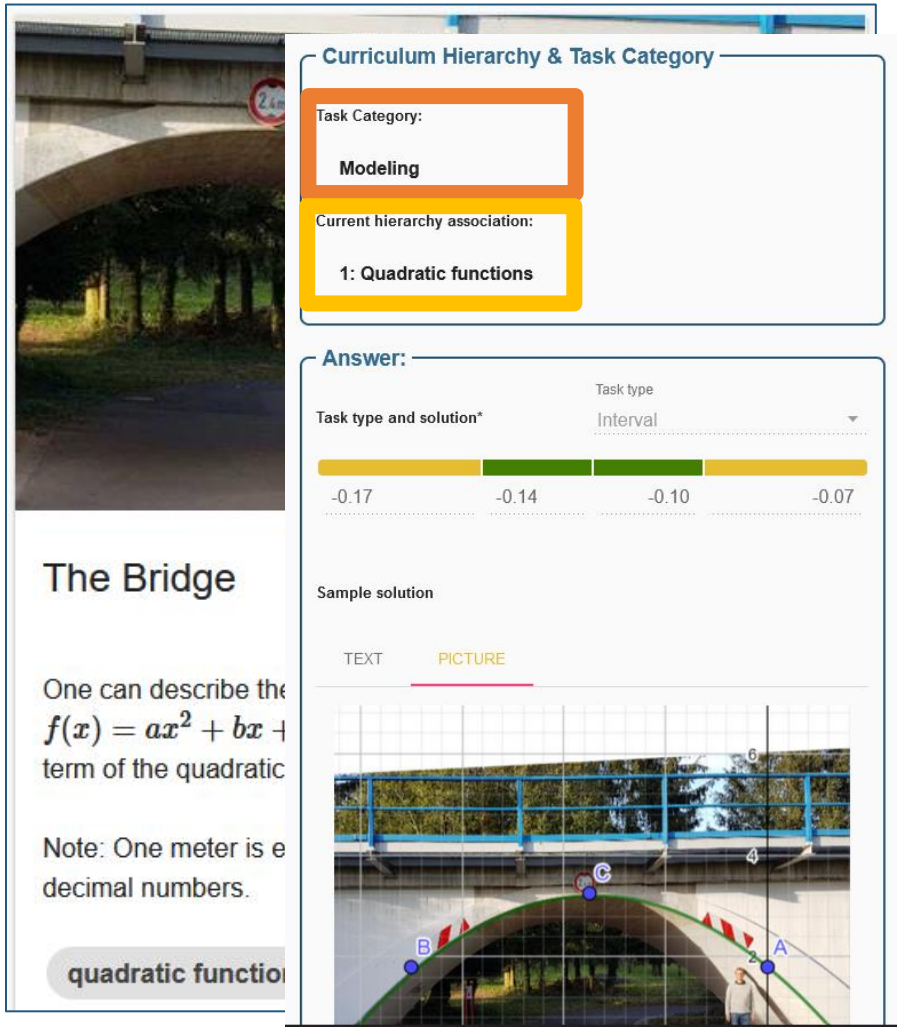
6. Stepped hints
7. Grade & Tags

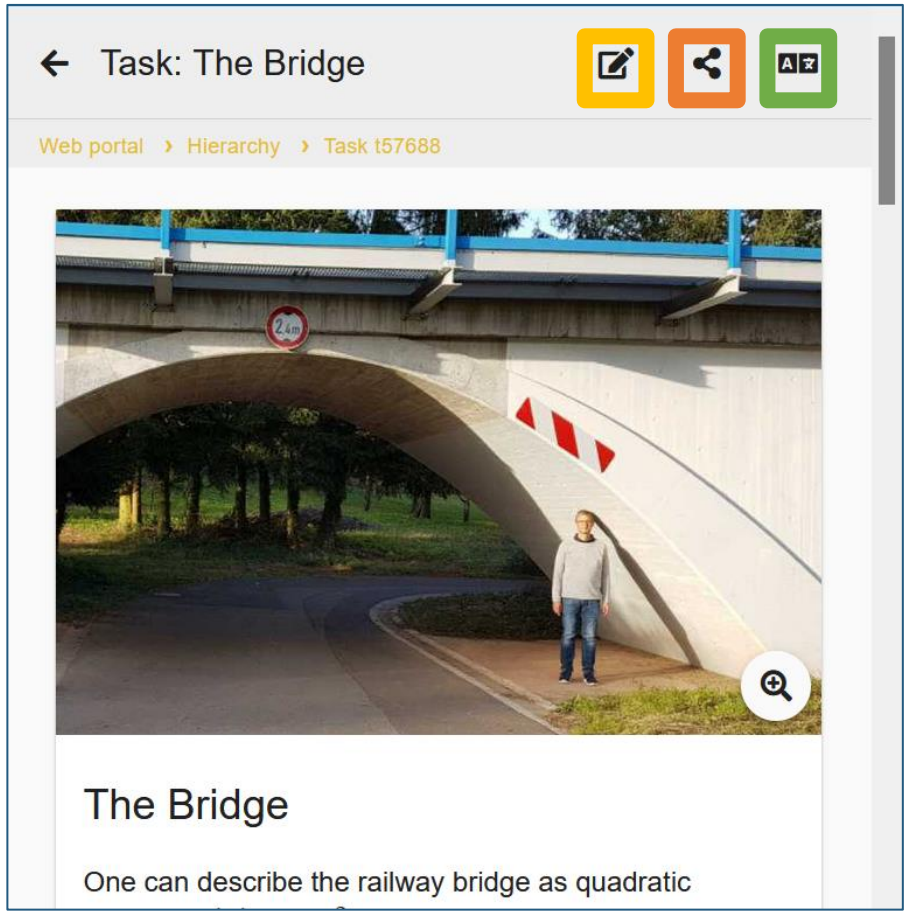


The Task Formular

As an example, please invoke the task “The bridge” (Link)

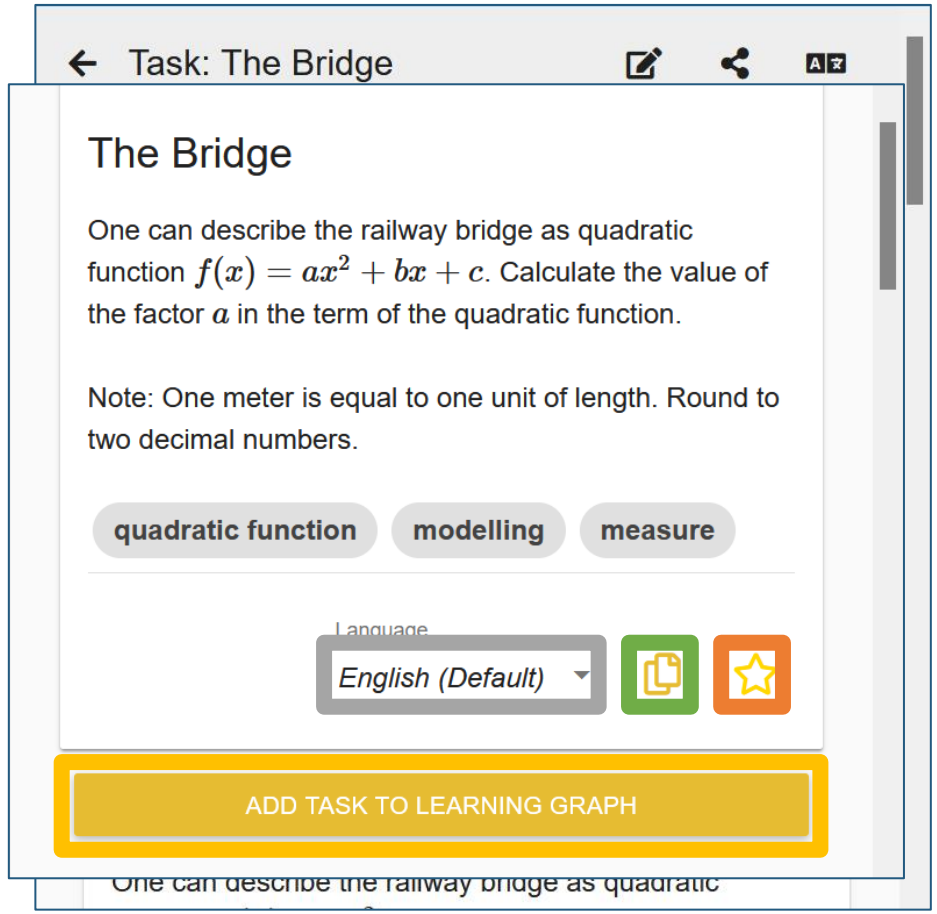
Furthermore, the task formular allows:

1. to edit own or shared tasks
2. to share a task *(more on that later)*
3. to translate a task



The Task Formular

As an example, please invoke the task “The bridge” (Link)



Furthermore, the task formular allows:

1. to edit own or shared tasks
2. to share a task *(more on that later)*
3. to translate a task
4. to display the translated tasks
5. to copy & adapt the task
6. to add it to the personal favorites
7. to add it to a learning graph *(more on that later)*

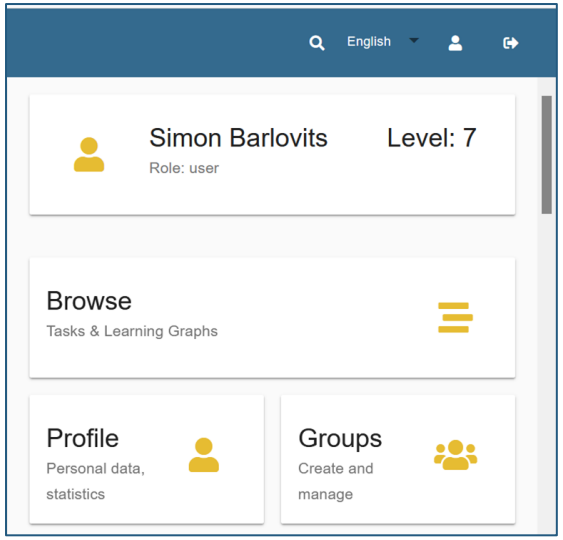
ASYMPTOTE Web Portal

6.3 Selection of Learning Graphs

Web Portal Functionalities

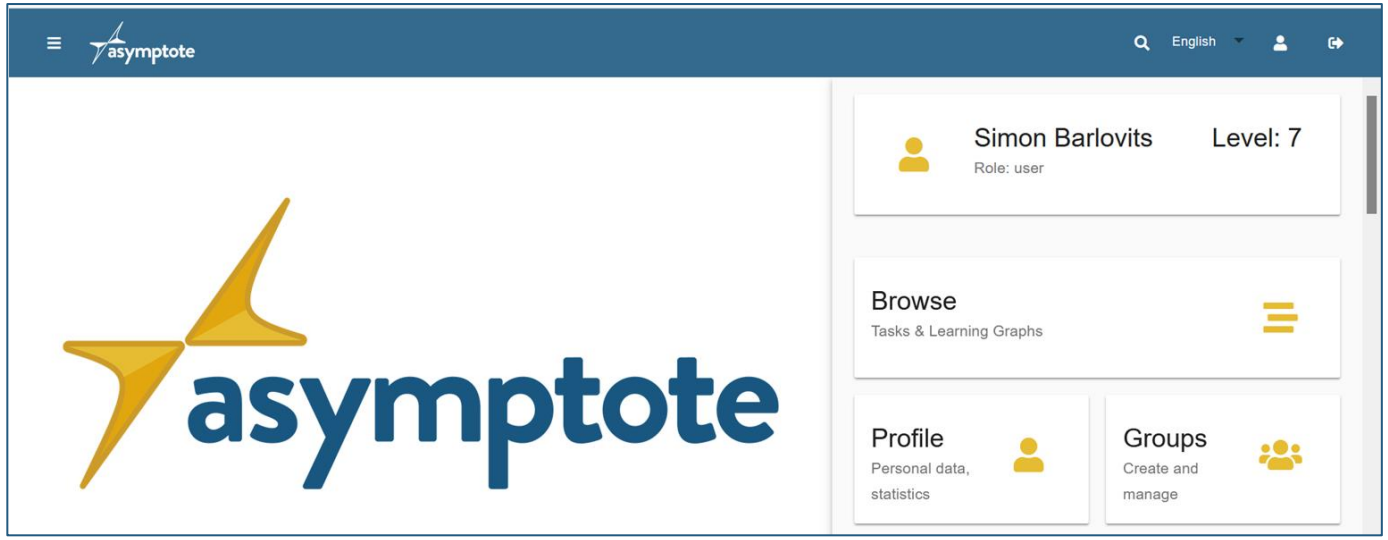
The ASYMPTOTE Web Portal offers the possibility …

1. **to select** digital tasks and **adaptive learning graphs from an open database**
2. to make own tasks and learning graphs available to other users
   - by sharing own tasks and learning graphs with groups
   - by making them publicly available for all users
3. to create own tasks and learning graphs
4. to monitor student's working progress in the Digital Classroom



Selection of Learning Graphs

1. Click on the “Browse” button
2. Select “Learning Graphs”
3. Search in the “Hierarchy” for the topic of your choice
4. Select and open a learning graph



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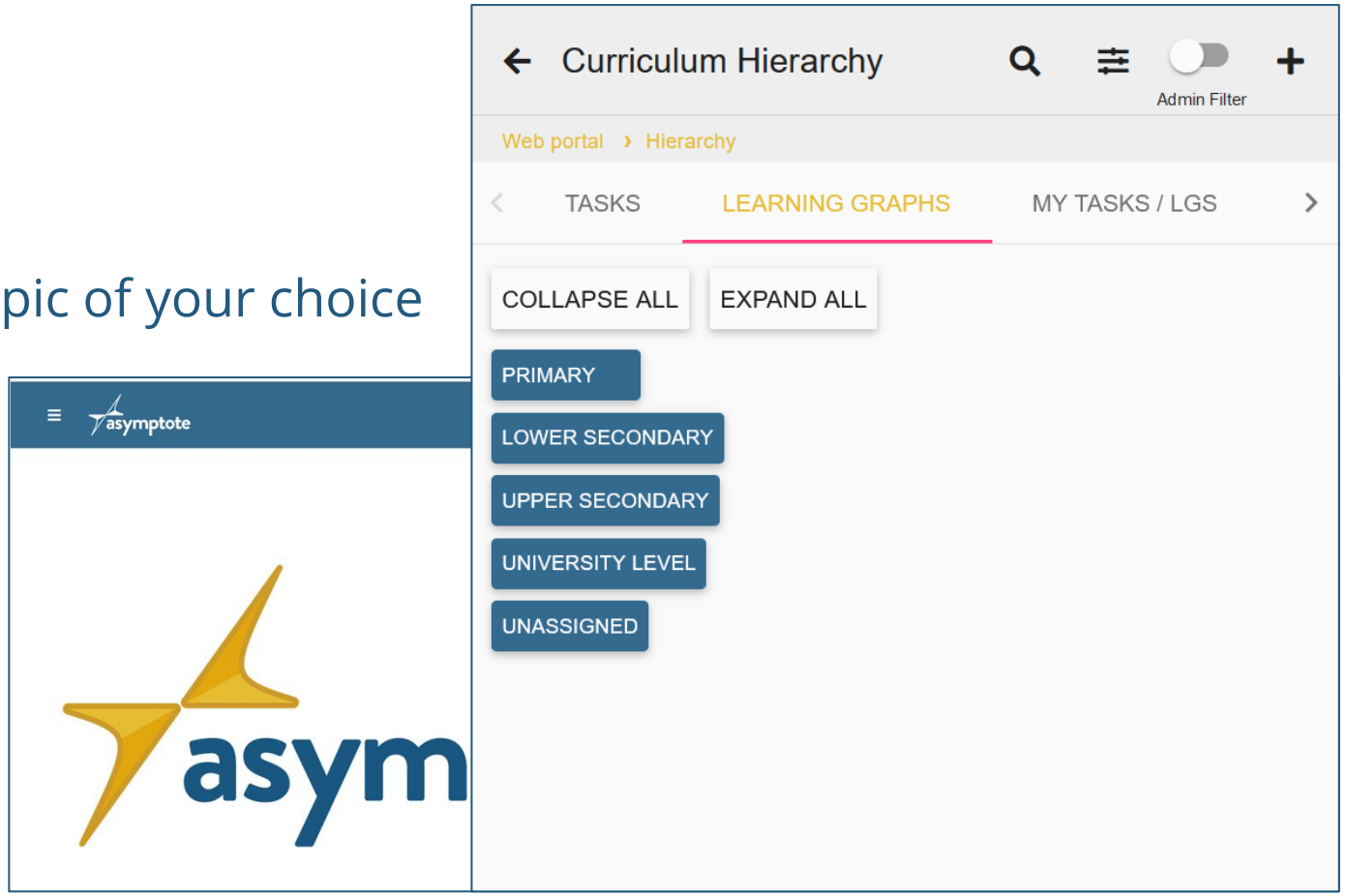
4. Select and open a learning graph



Selection of Learning Graphs

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3. Search in the “Hierarchy” for the topic of your choice
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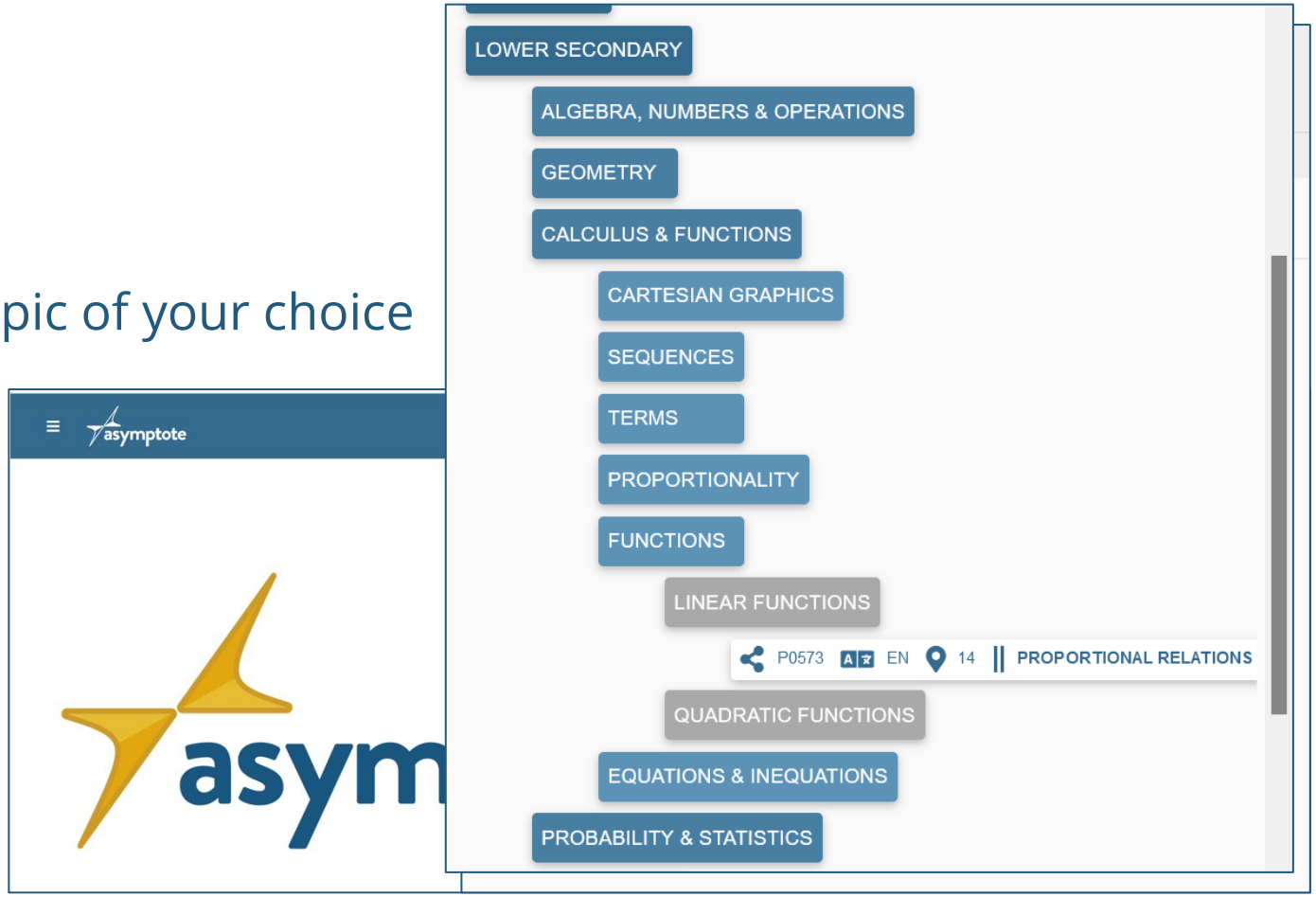

Selection of Learning Graphs

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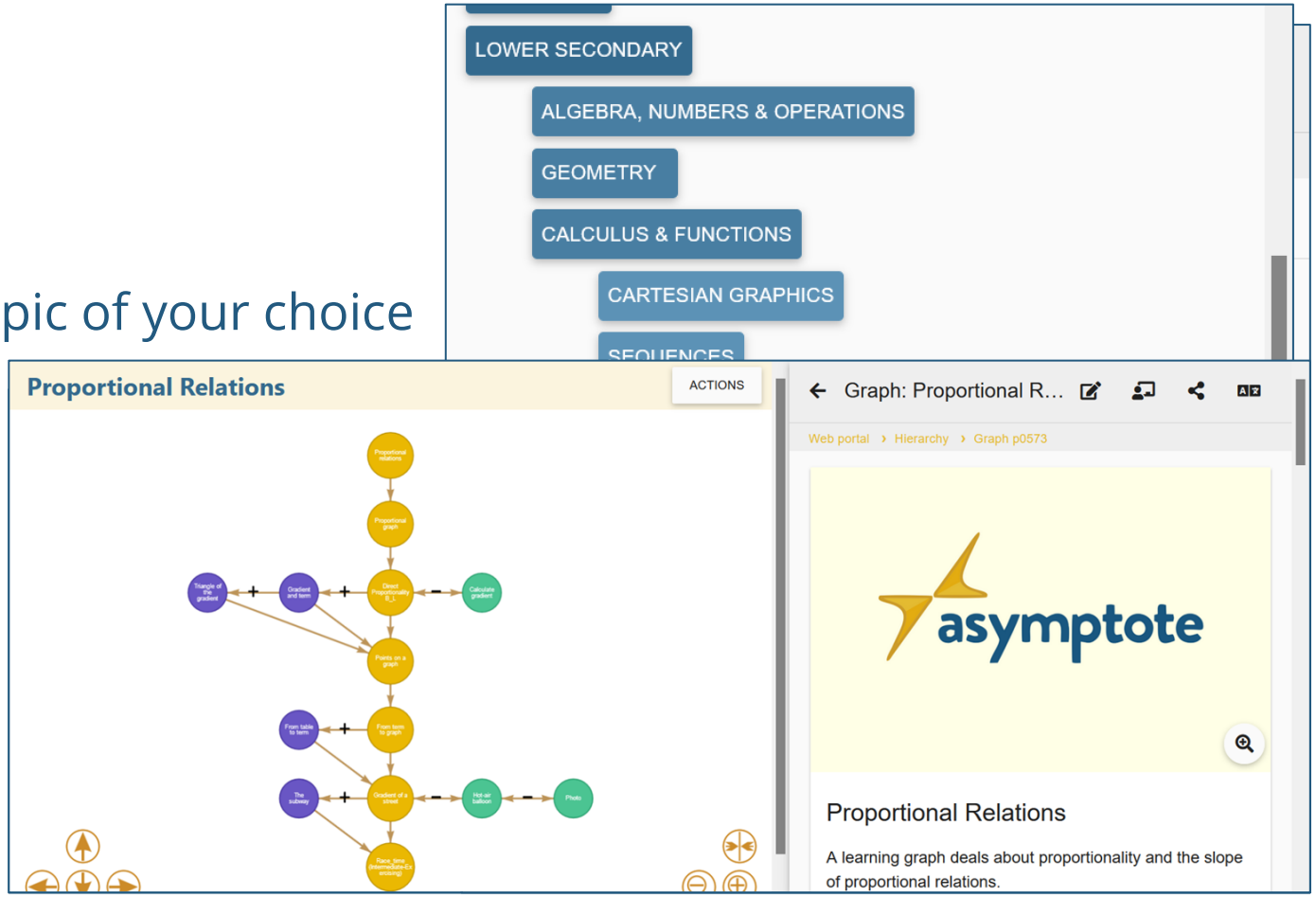
4. Select and open a learning graph



Selection of Learning Graphs

1. Click on the “Browse” button
2. Select “Learning Graphs”
3. Search in the “Hierarchy” for the topic of your choice
4. Select and open a learning graph

As practice, please invoke the learning graph “Proportional Relations”.

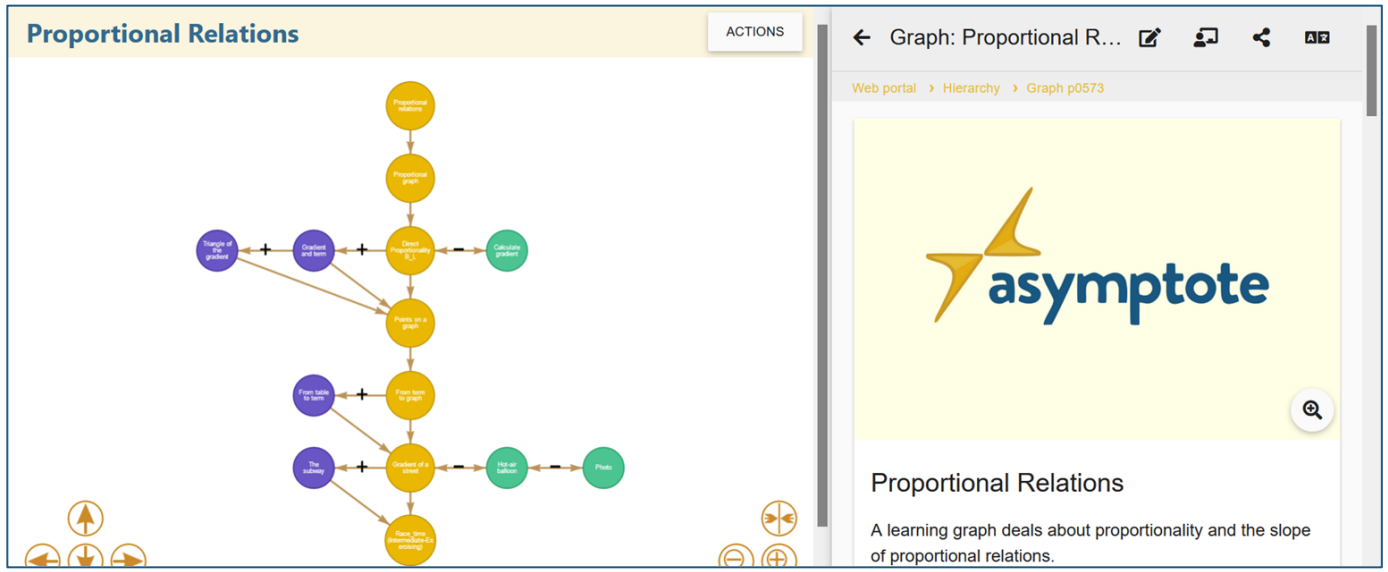
It is a learning graph (LG) on lower secondary level treating linear functions

The Learning Graph View

As an example, please invoke the LG “Proportional Relations” (Link)

A learning graph consists of:

1. Title & learning graph description
2. Picture (optional)
3. Tasks
4. Curriculum hierarchy
5. Grade
6. Settings



The Learning Graph View

As an example, please invoke the LG “Proportional Relations” (Link)

A learning graph consists of:

1. Title & learning graph description
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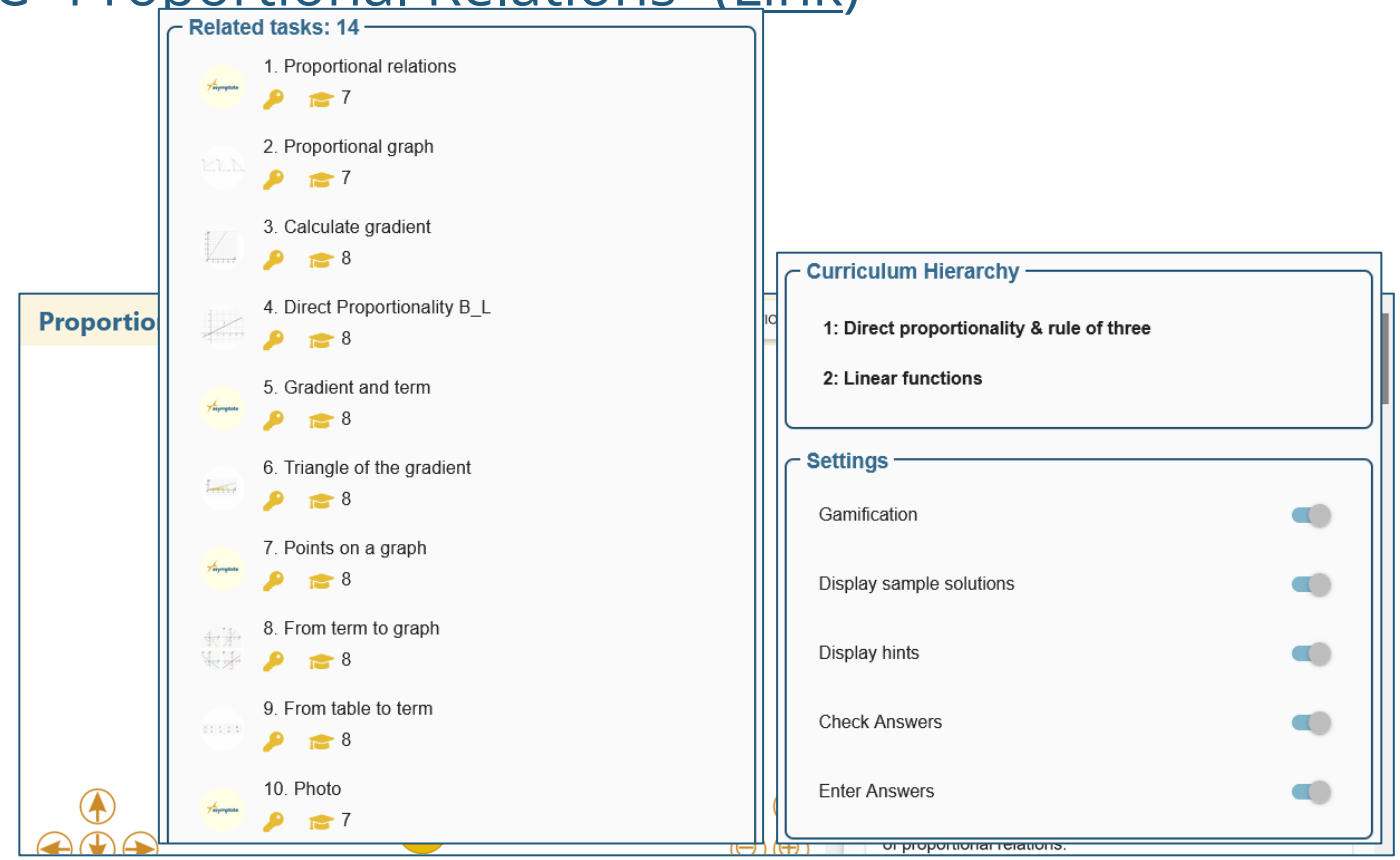
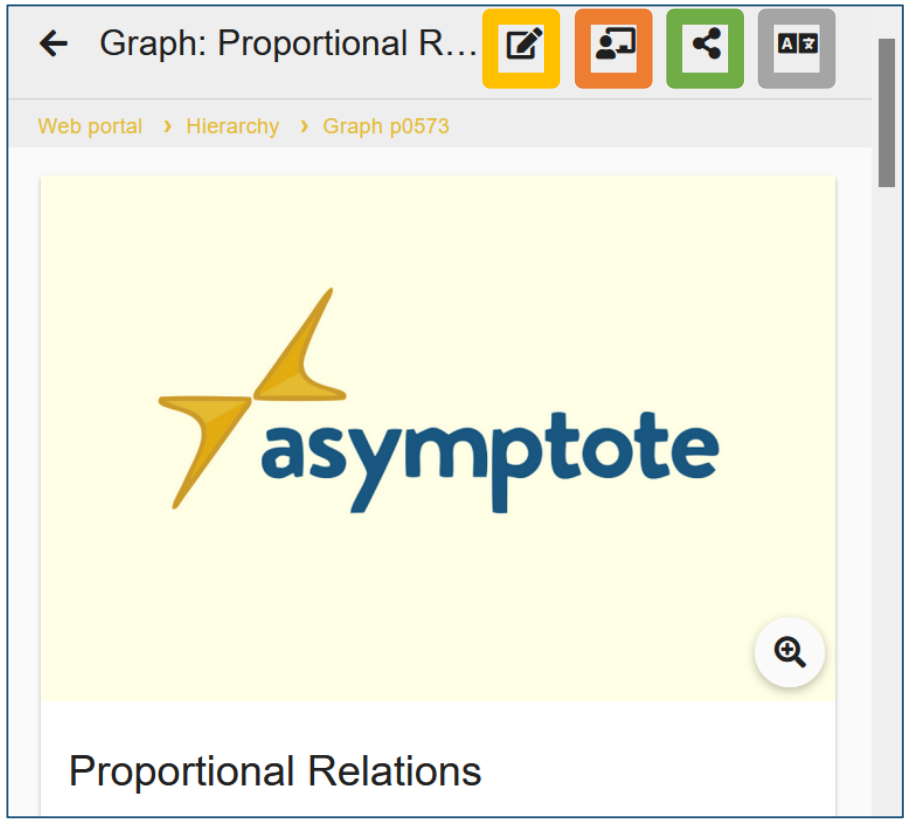


The Learning Graph View

As an example, please invoke the LG “Proportional Relations” (Link)

Furthermore, the LG formular allows:

1. to edit the LG
2. to create a Digital Classroom *(more on that later)*
3. to share the LG *(more on that later)*
4. to translate the LG

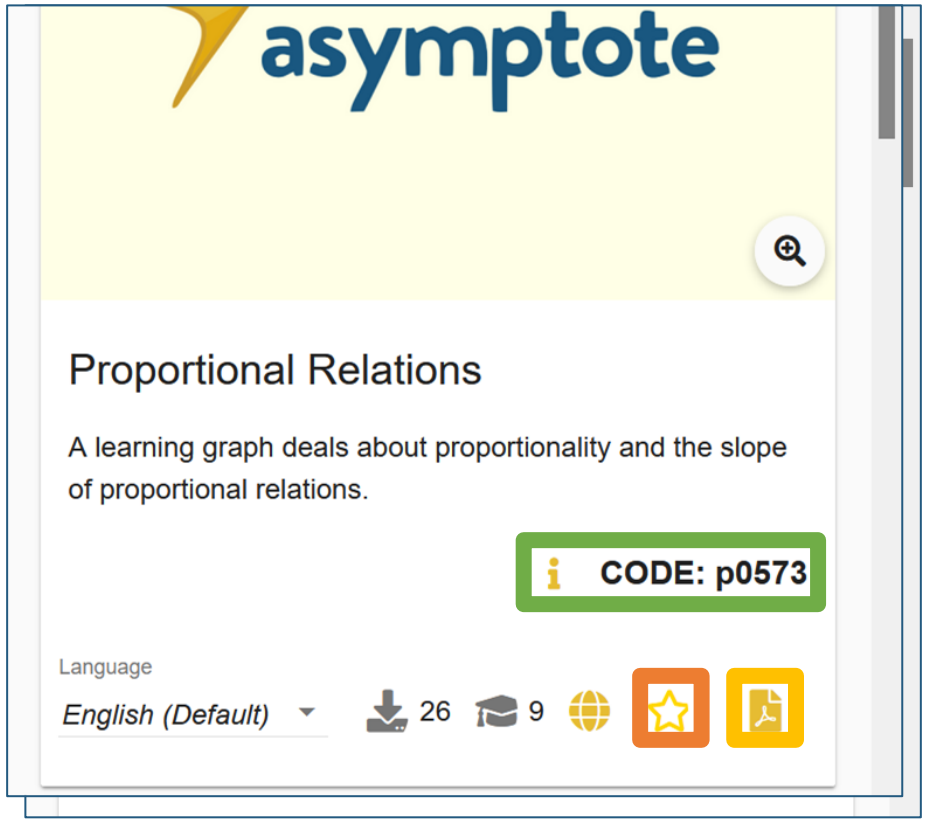


The Learning Graph View

As an example, please invoke the LG “Proportional Relations” (Link)

Furthermore, the LG formular allows:

1. to edit the LG
2. to create a Digital Classroom *(more on that later)*
3. to share the LG *(more on that later)*
4. to translate the LG
5. to invoke the LG in the ASYMPTOTE app *(via Code)*
6. to add it to the personal favorites
7. to download the LG as PDF

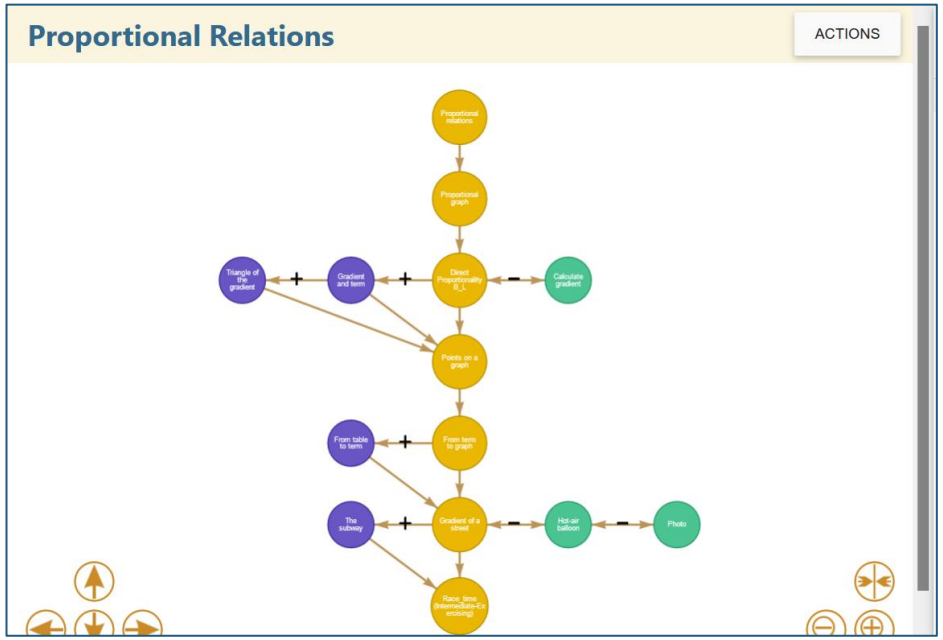


The Learning Graph View

As an example, please invoke the LG “Proportional Relations” (Link)

In the web portal, the possible *learning trajectories* of the student’s are displayed:

1. Main tasks (yellow) are mandatory
2. Support tasks (green) are mandatory after two wrong entries in the app or optional by less incorrect entries
3. Challenge tasks (purple) are optional (unlocked after solving a main task)



Core idea: To allow all students to work on their individual performance level on a common topic

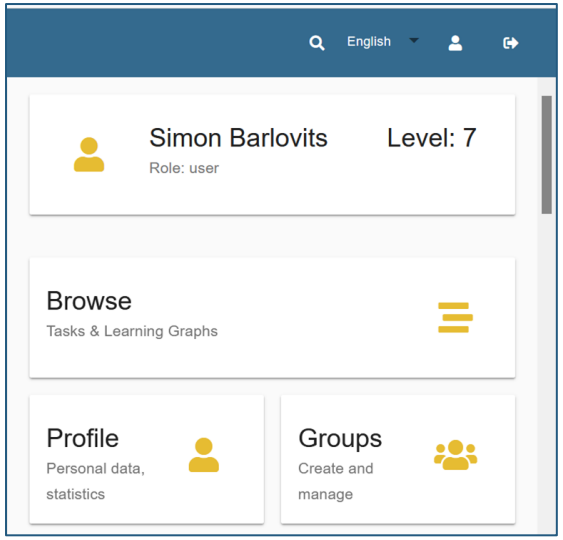
ASYMPTOTE Web Portal

6.4 Sharing & Publication of Contents

Web Portal Functionalities

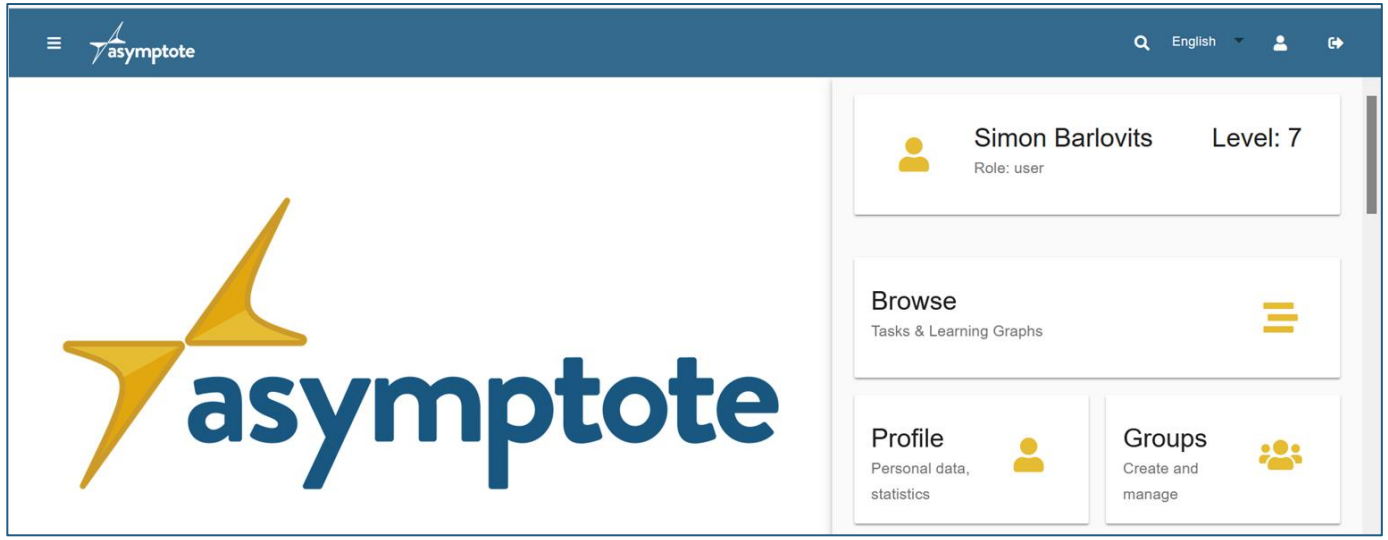
The ASYMPTOTE Web Portal offers the possibility …

1. to select digital tasks and adaptive learning graphs from an open database
2. **to make own tasks and learning graphs available to other users**
   - *by sharing own tasks and learning graphs with groups*
   - by making them publicly available for all users
3. to create own tasks and learning graphs
4. to monitor student's working progress in the Digital Classroom



Manage my Groups

1. Click on the “Group” button
2. Overview on your groups
3. Invoke shared tasks & LG
   by clicking on a group
4. Possibility to leave or share group
   (sharing via code = group no.)
5. Possibility to delete group
   (only for group owners)



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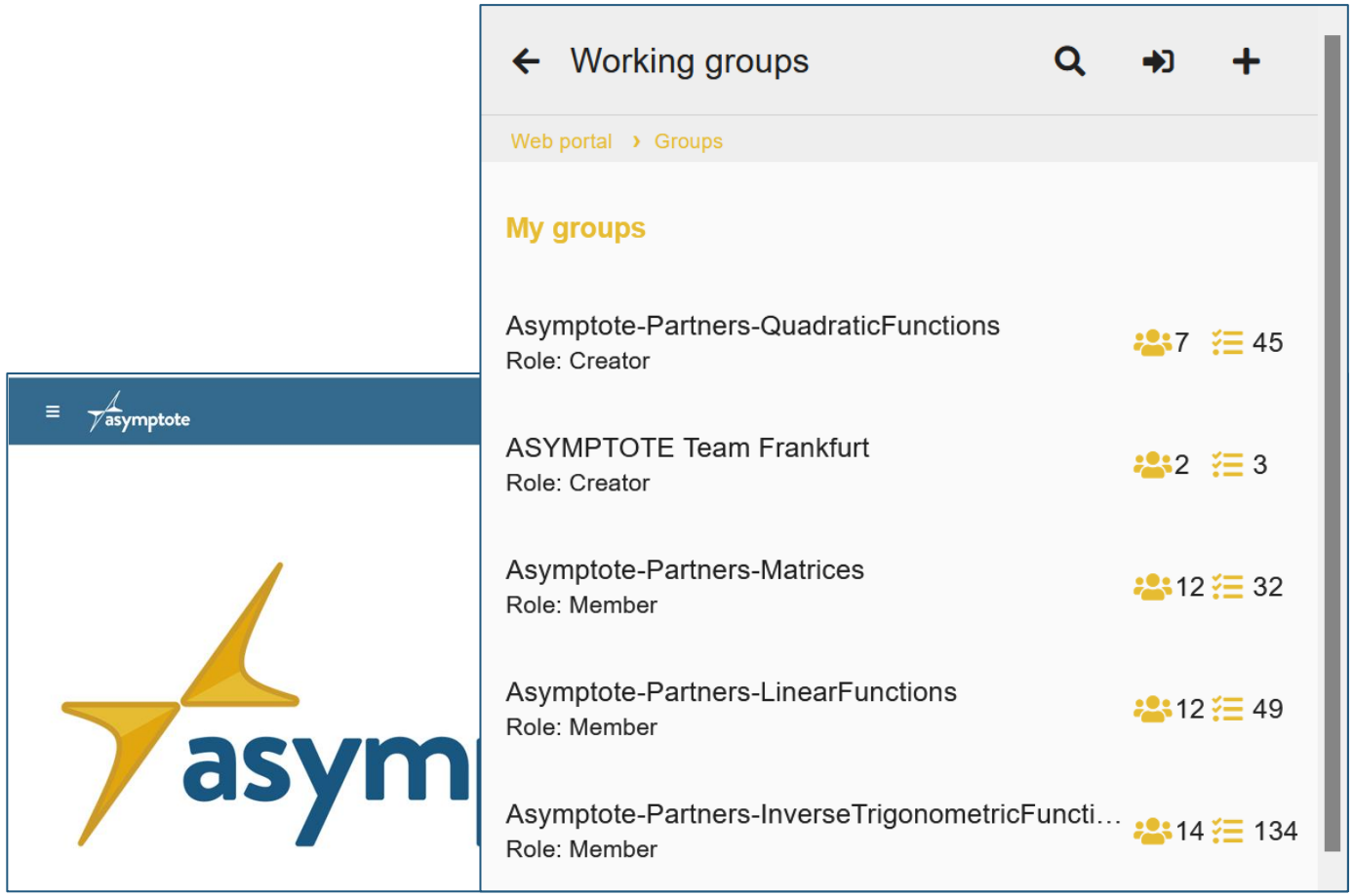

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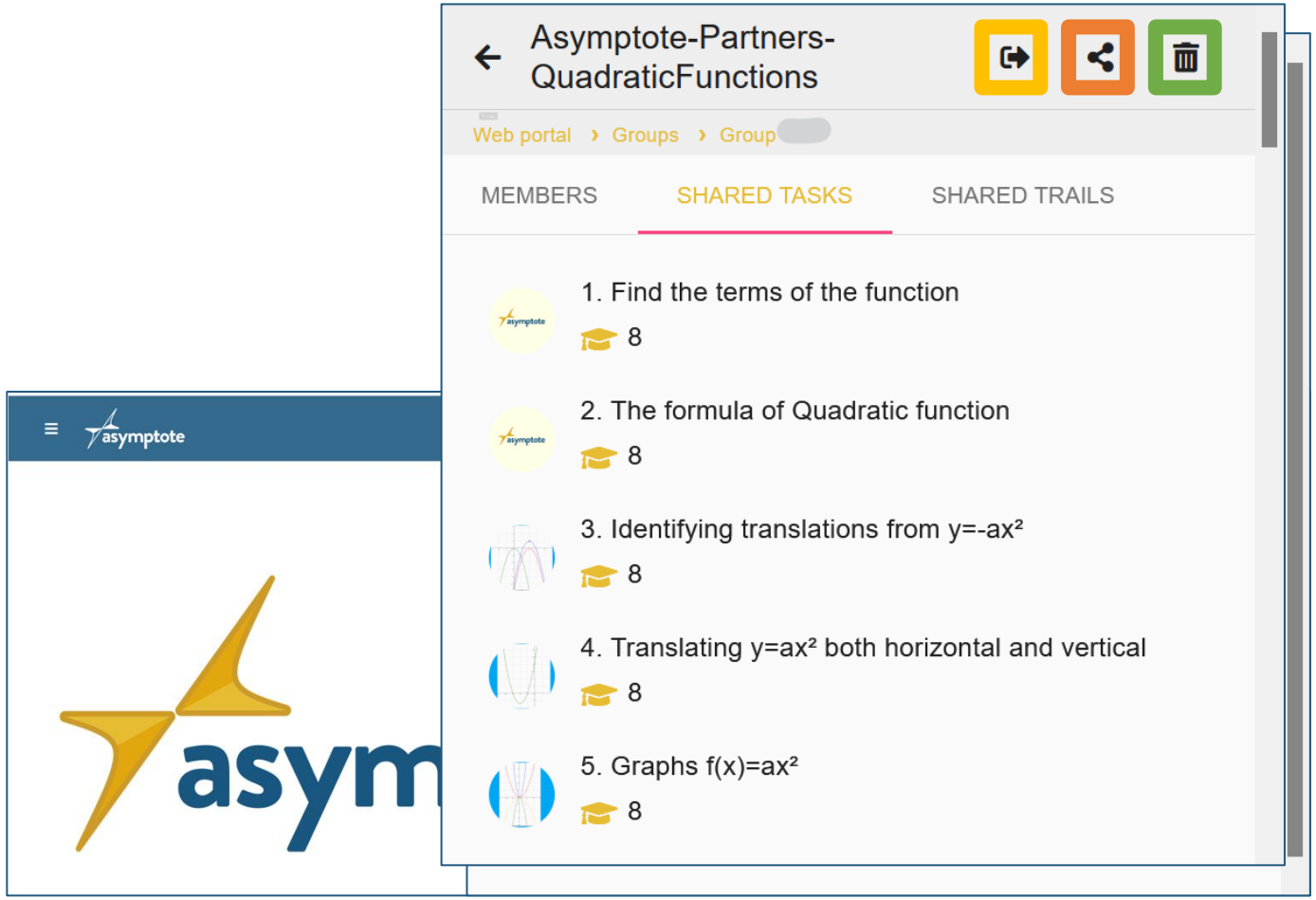
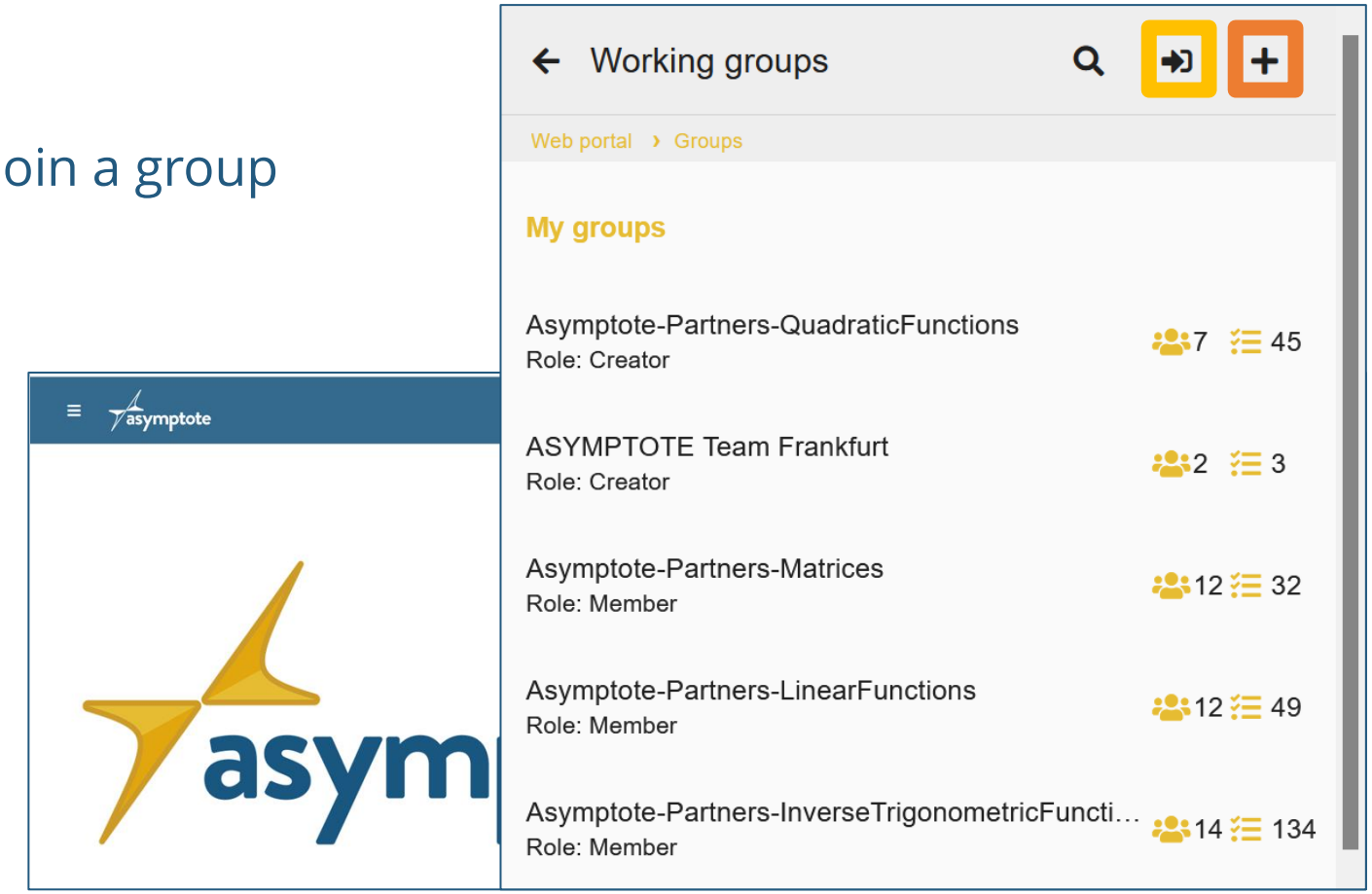


Create or Join a Groups

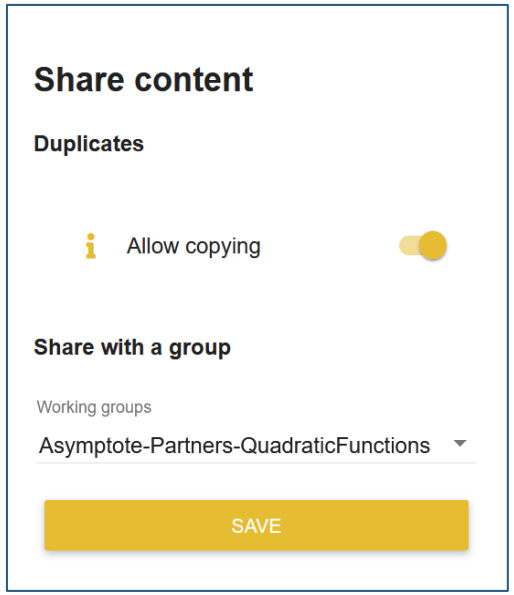
1. Click on the “Group” button
2. Click on the “Entrance” symbol to join a group via code *(code = group no.)*
3. Click on the “+” symbol to create a new group

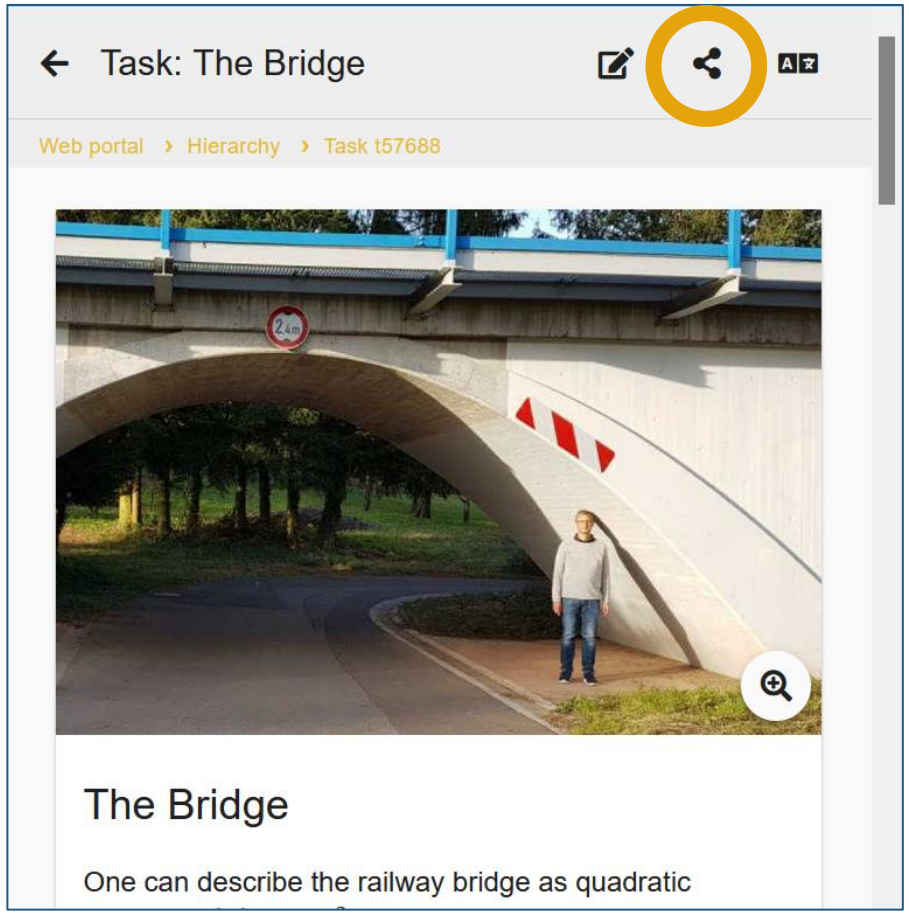


Share a Task or a Learning Graph with a Group

To share a task or a LG …

1. invoke the task/LG
2. click on the “Share” button
3. select one of your groups





Information:

a) each task/LG can only be shared with one group
b) sharing a task/LG allows all group members its editing

Web Portal Functionalities

The ASYMPTOTE Web Portal offers the possibility …

1. to select digital tasks and adaptive learning graphs from an open database
2. **to make own tasks and graphs available to other users**
   - by sharing own tasks and graphs with groups
   - *by making them publicly available for all users*
3. to create own tasks and learning graphs
4. to monitor student's working progress in the Digital Classroom

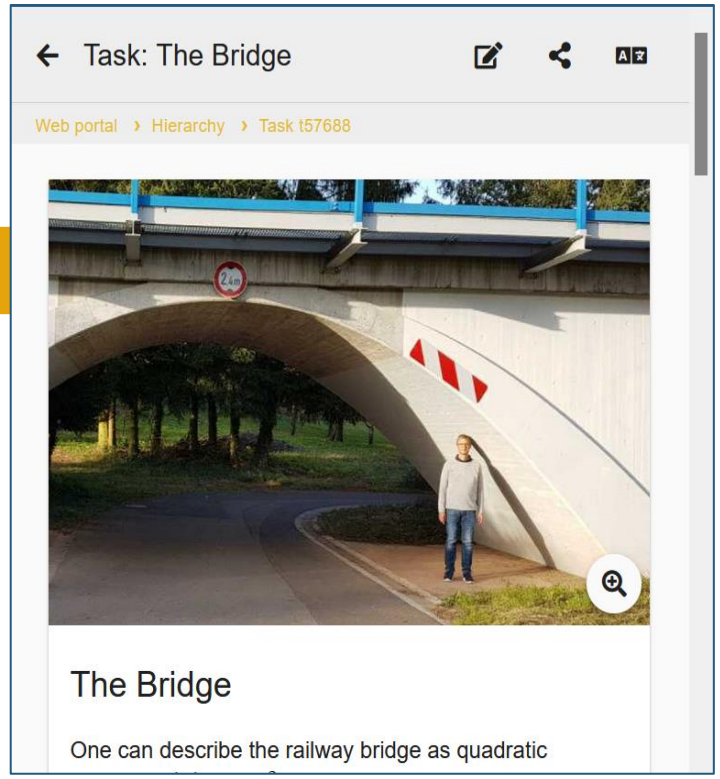
Make a Task or a Learning Graph Public Available

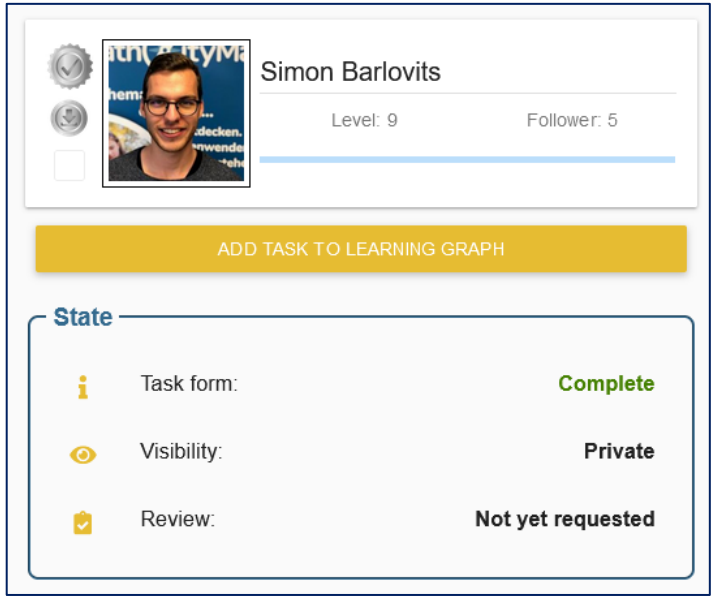
To make a task or a LG public available …

1. invoke the task/LG
2. click on the “Review” button
3. confirm having image rights and respecting quality standards

Information:

a) each task/LG will be reviewed by the ASYMPTOTE team
b) It will be visible for all users after a successful review





ASYMPTOTE Web Portal

6.5 Creation of Tasks

Web Portal Functionalities

The ASYMPTOTE Web Portal offers the possibility …

1. to select digital tasks and adaptive learning graphs from an open database
2. to make own tasks and graphs available to other users
   - by sharing own tasks and graphs with groups
   - by making them publicly available for all users
3. **to create own tasks** and learning graphs
4. to monitor student's working progress in the Digital Classroom

Overview

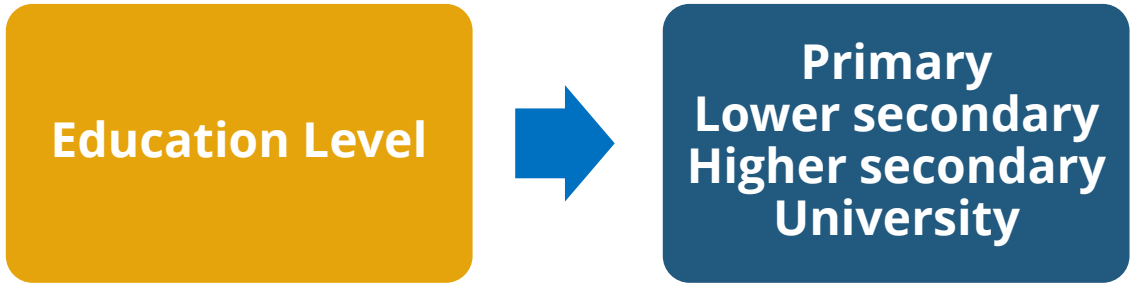
Let´s create a task!

1. Criteria to create tasks and task categories
2. Categories details
3. How to create a task in asymptote web portal

Criteria to create tasks and task categories

Education Level

Education level are an ordered set of categories, intended to group educational programs.



Task Categories

Learning	Training	Reasoning	Modeling
learning tasks, the aids must teach how to solve the task.	task for resolution of exercises of direct application of concepts.	task for solving exercises that are not direct application of concepts.	tasks that involve modeling the problem before solving it.

Task details

- **Title image:** a representative image for the task.
- **Basic data:**
  - **Title**
  - **Definition of task**
- **Task format:** task type and solution which is interval, exact value, multiple choice, fill in the blanks, vector(exact value), vector (interval), set and information station.
- **Sample solution:** Type of solution is text or picture. A solution plan should be added for every task. This plan will be visible for student/learner after solving the task.
- **Hints:** Type of hint is text, picture or video. Minimum: 2 hints.
- **Curriculum Hierarchy & Task Category:**
  - **Task category:** learning, training, reasoning and modeling.
  - **Curriculum association: Selection of the mathematical topic, e.g. linear functions**
- **Grade & Tags:**
  - **From grade: 1 to 13**
  - **Tags**

How to create a learning graph in ASYMPTOTE web portal

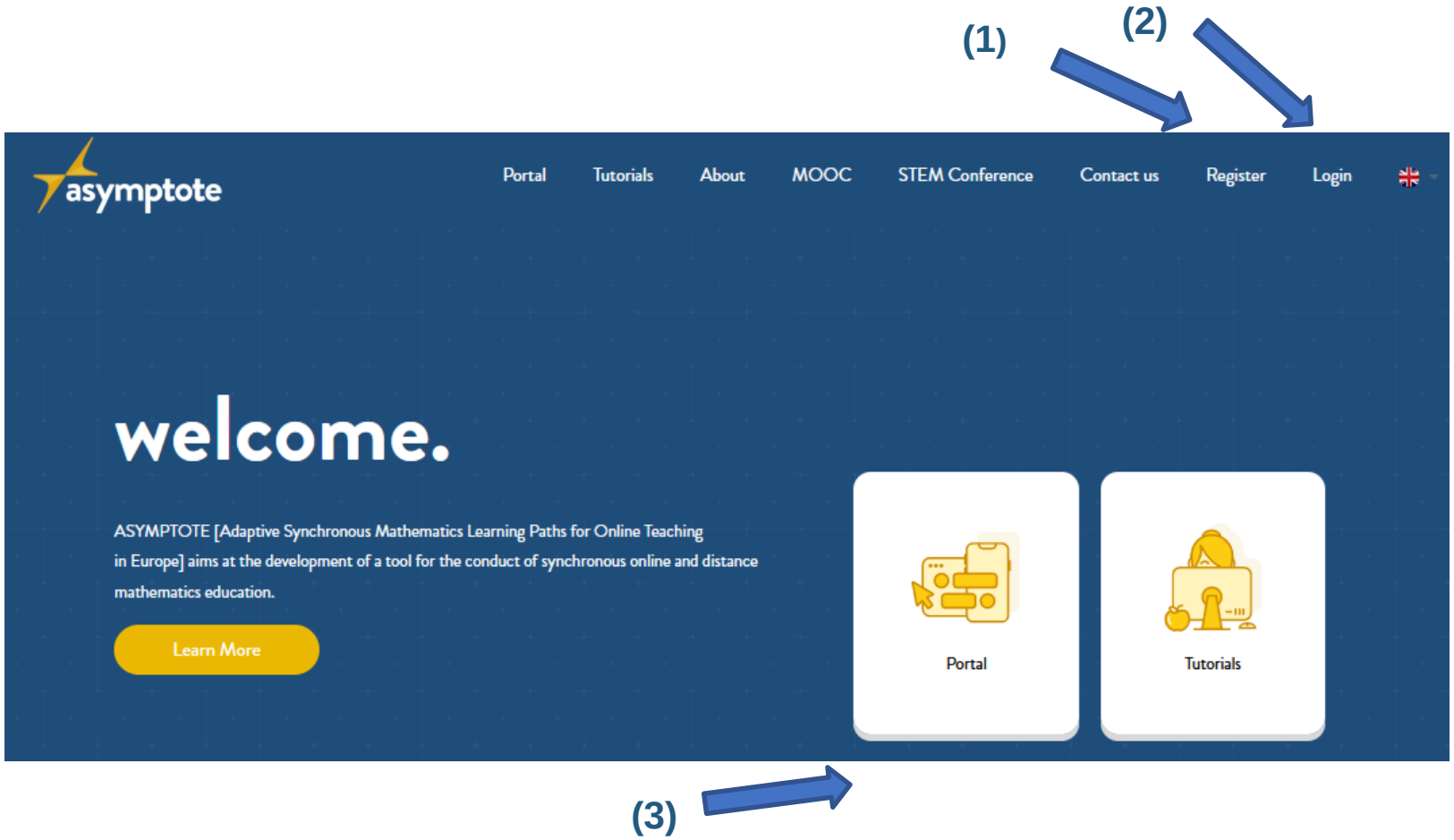
Login to the portal page

https://www.asymptote-project.eu/en/welcome/

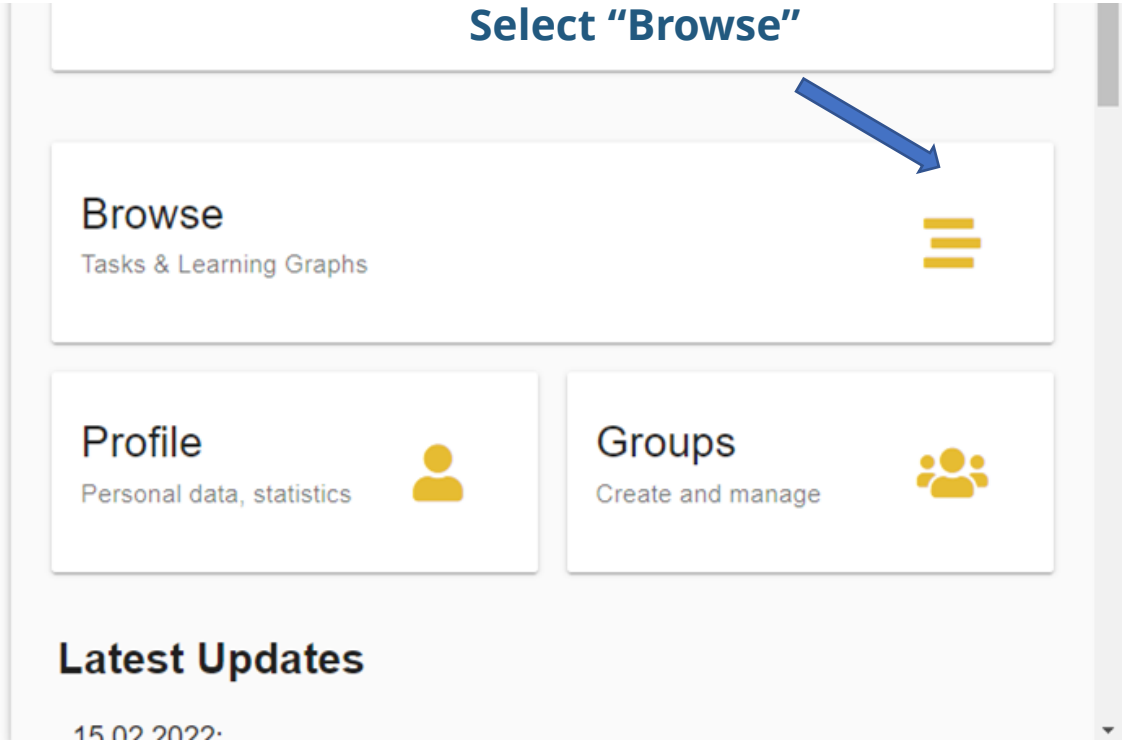
(1) Register

(2) Login

(3) Enter at the portal

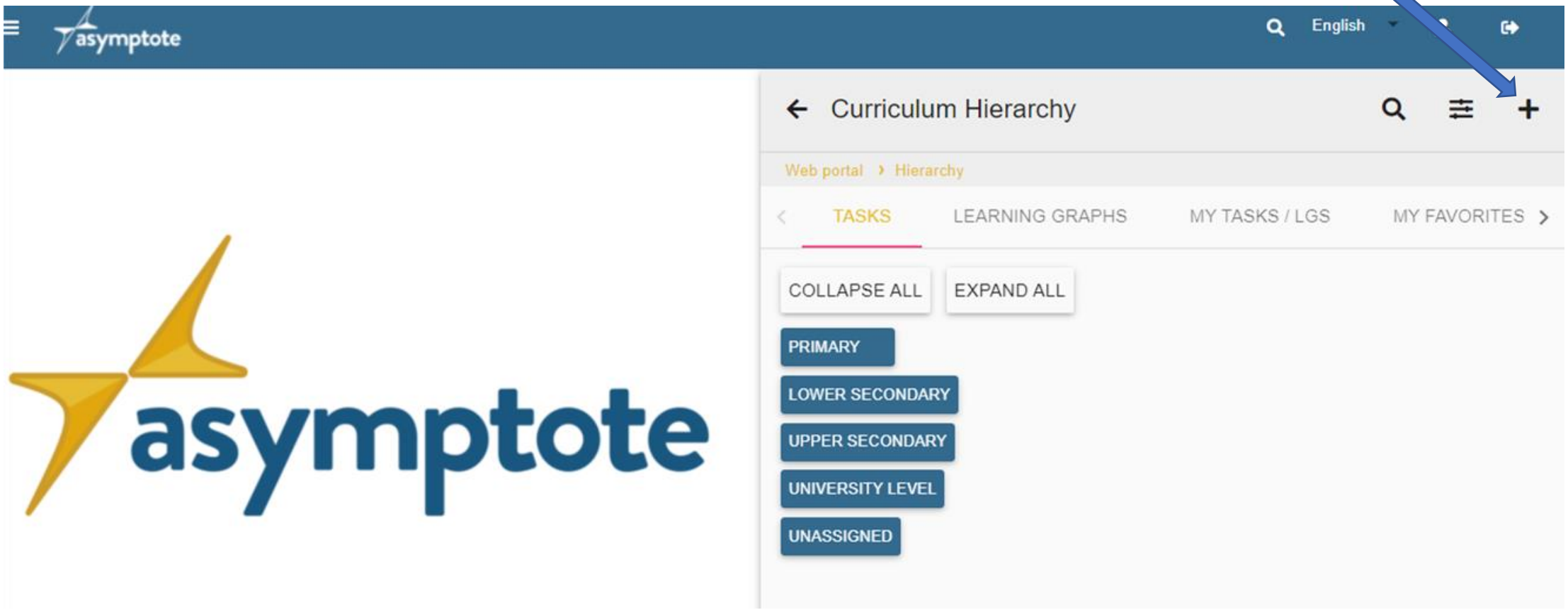


How to create a task in asymptote web portal

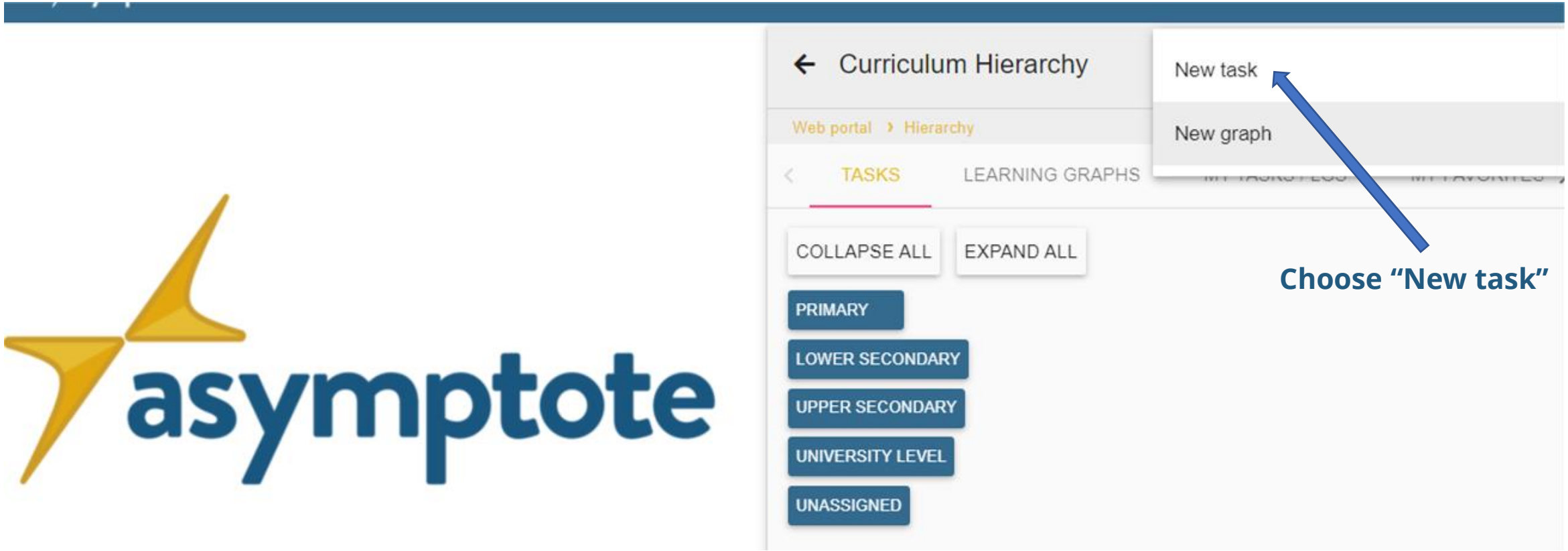


How to create a task in asymptote web portal

Click on the button “+”



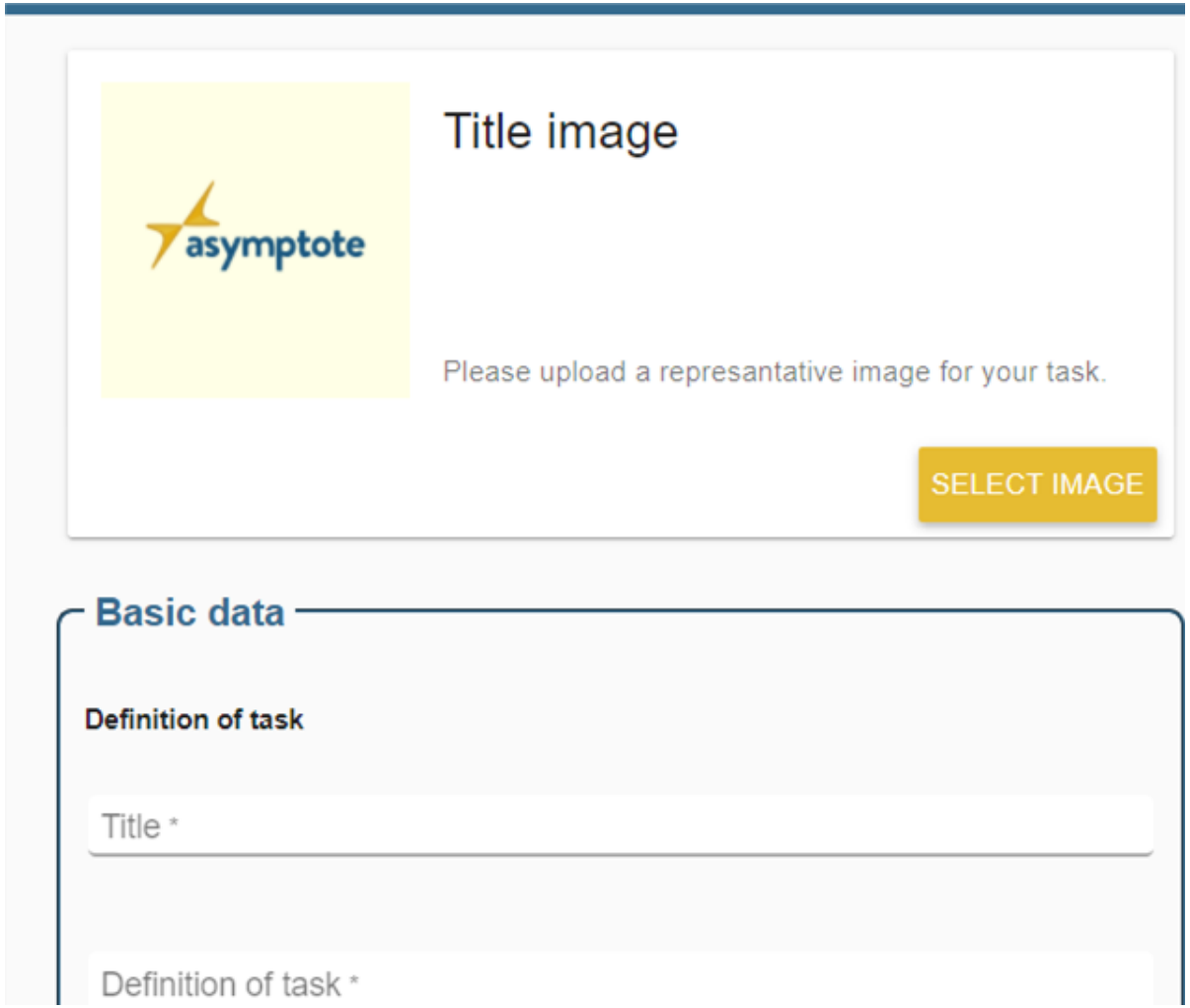
How to create a task in asymptote web portal



How to create a task in asymptote web portal

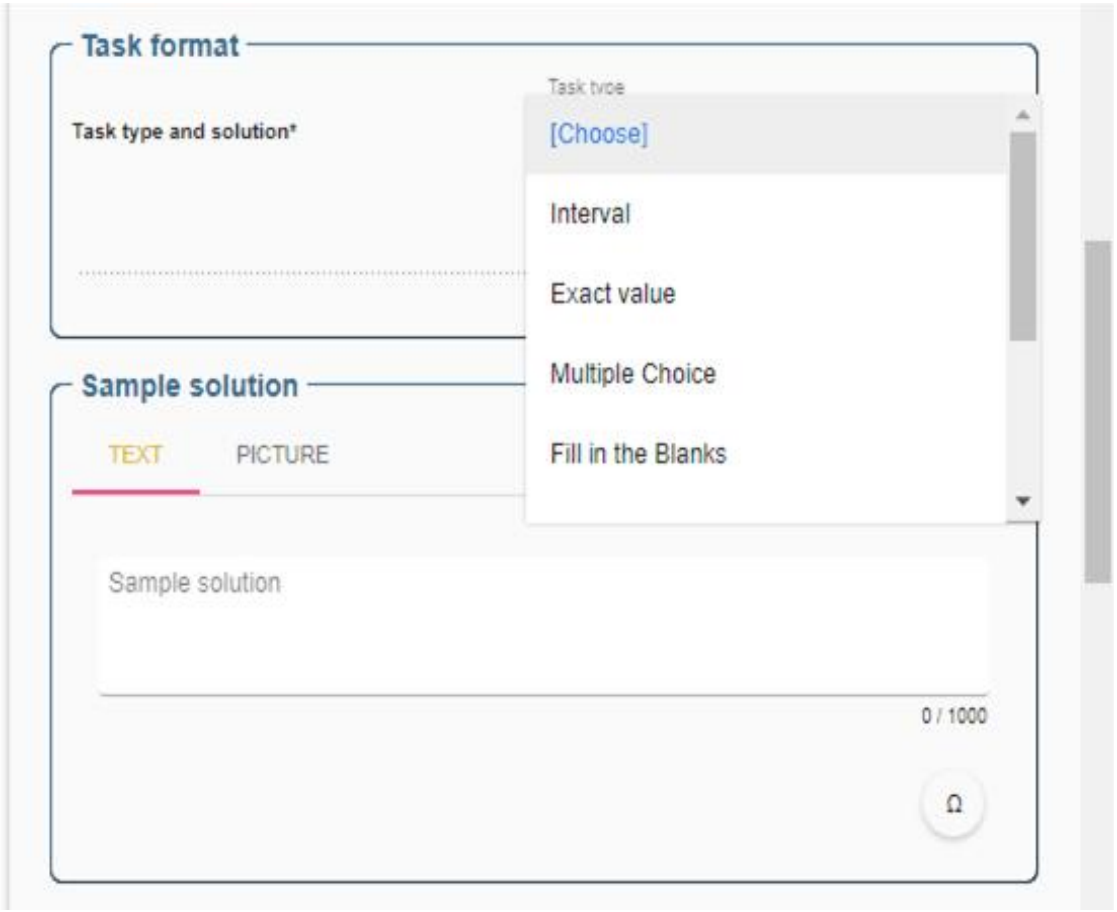
Fill the form:

- The image is only mandatory if the task is of the modeling type, otherwise it is optional.
- In the “Definition of task” describe what must be done in this task (task formulation).



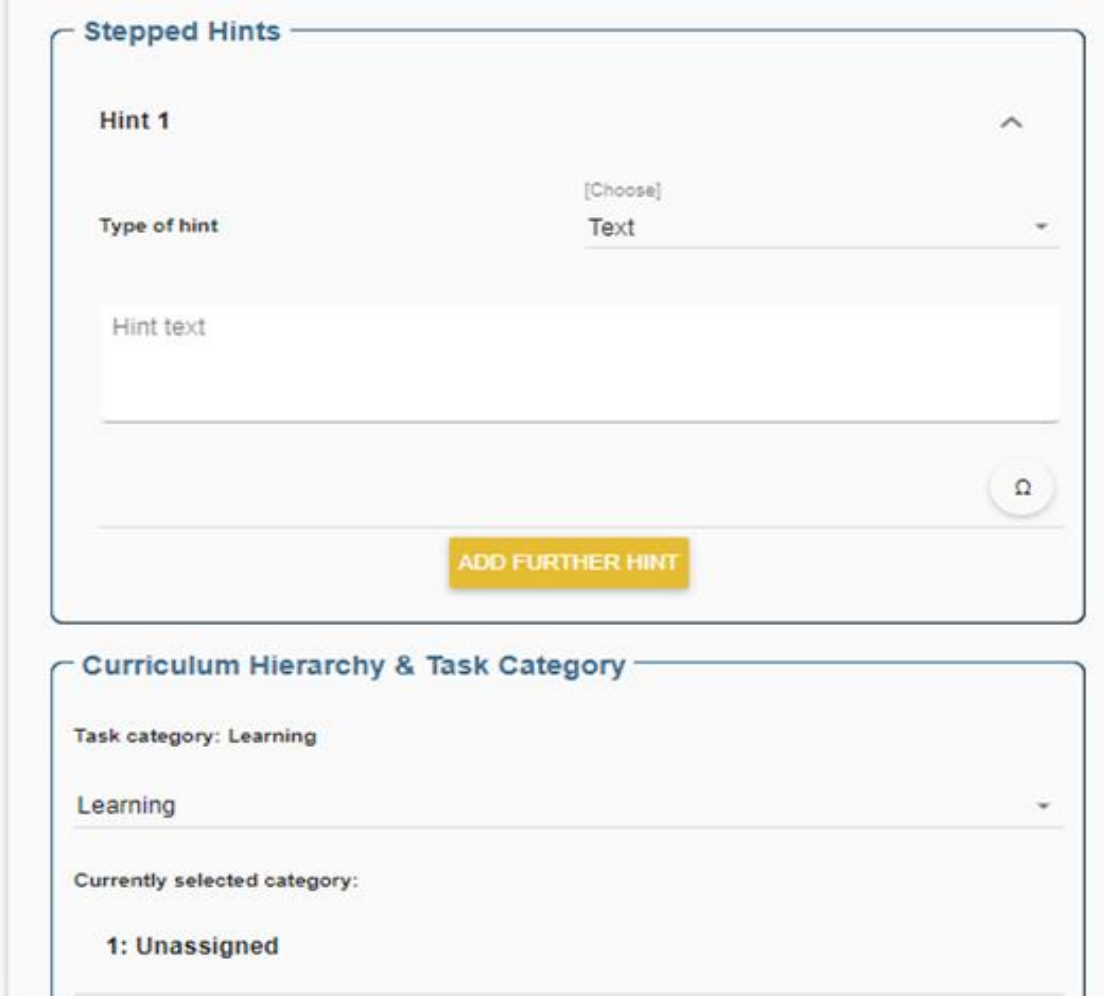
How to create a task in asymptote web portal

- **Task format –** choose an appropriate answer type of the task.
- **Sample solution -** enter a task resolution.



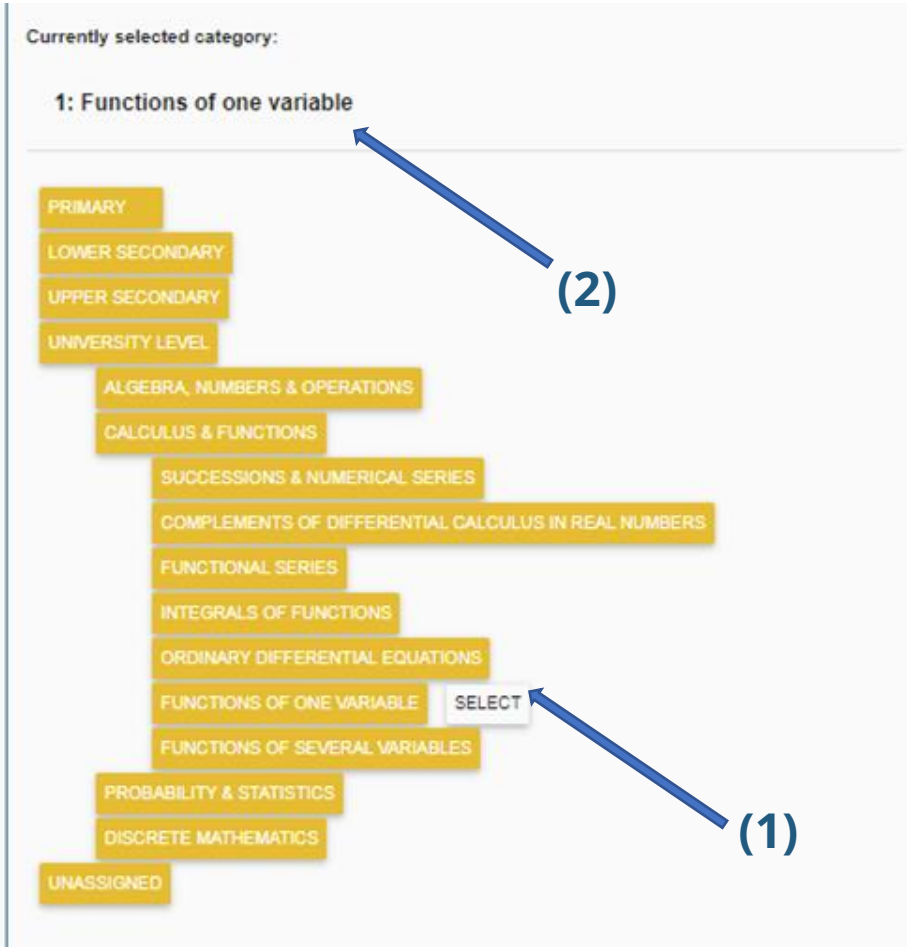
How to create a task in asymptote web portal

- **Stepped Hints -** put at least 2 hints.
- **Curriculum Hierarchy & Task Category -** select the task category and the Education Level

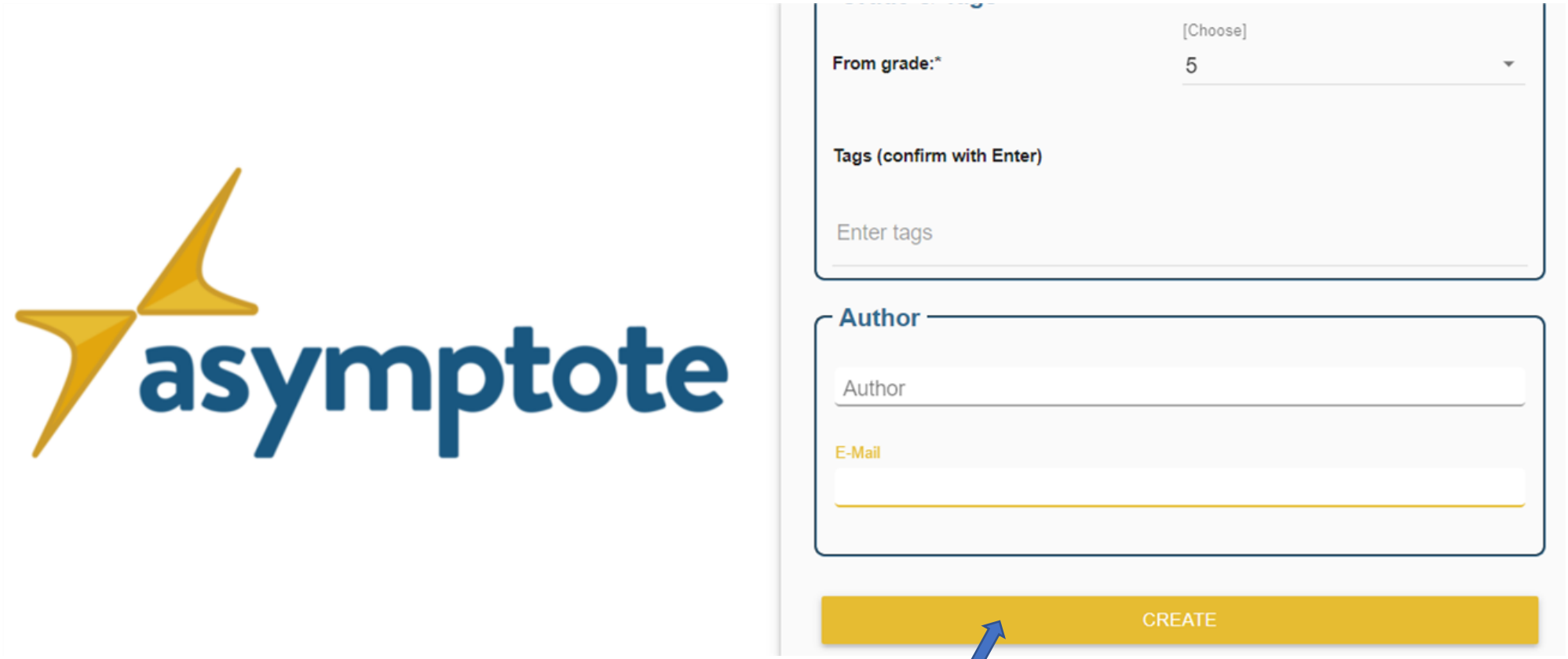


How to create a task in asymptote web portal

- In “Currently selected category” press “select” (1) and verify that the selected category is correct (2).
- Grade & Tags – select a grade from 1 to 13 and assign at least one topic-related tag.



How to create a task in asymptote web portal



After filling out the form select “create”

ASYMPTOTE Web Portal

6.6 Creation of Tasks

Interval

- Tasks that require some latitude, such as modeling, estimating, or rounding.

Exact value

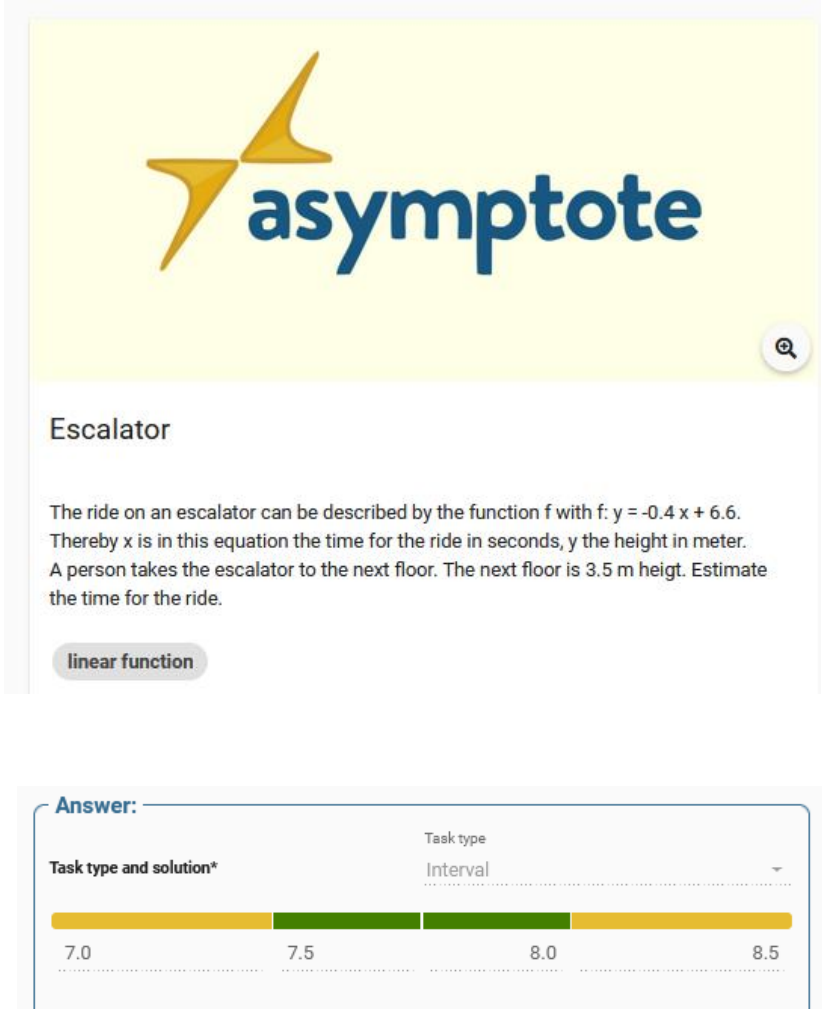
- Tasks with exact result, e.g. arithmetic problems & combinatorial problems.

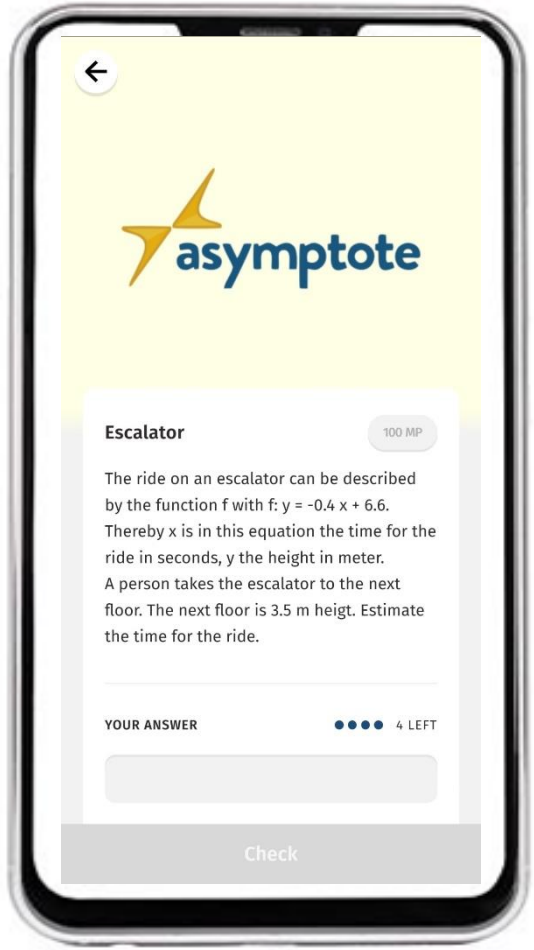
Multiple Choice

- Quiz tasks & true/false statement query

Fill in the Blanks

- Tasks for learning technical terms and language





Interval

- Tasks that require some latitude, e.g., modeling & estimating.

Exact value

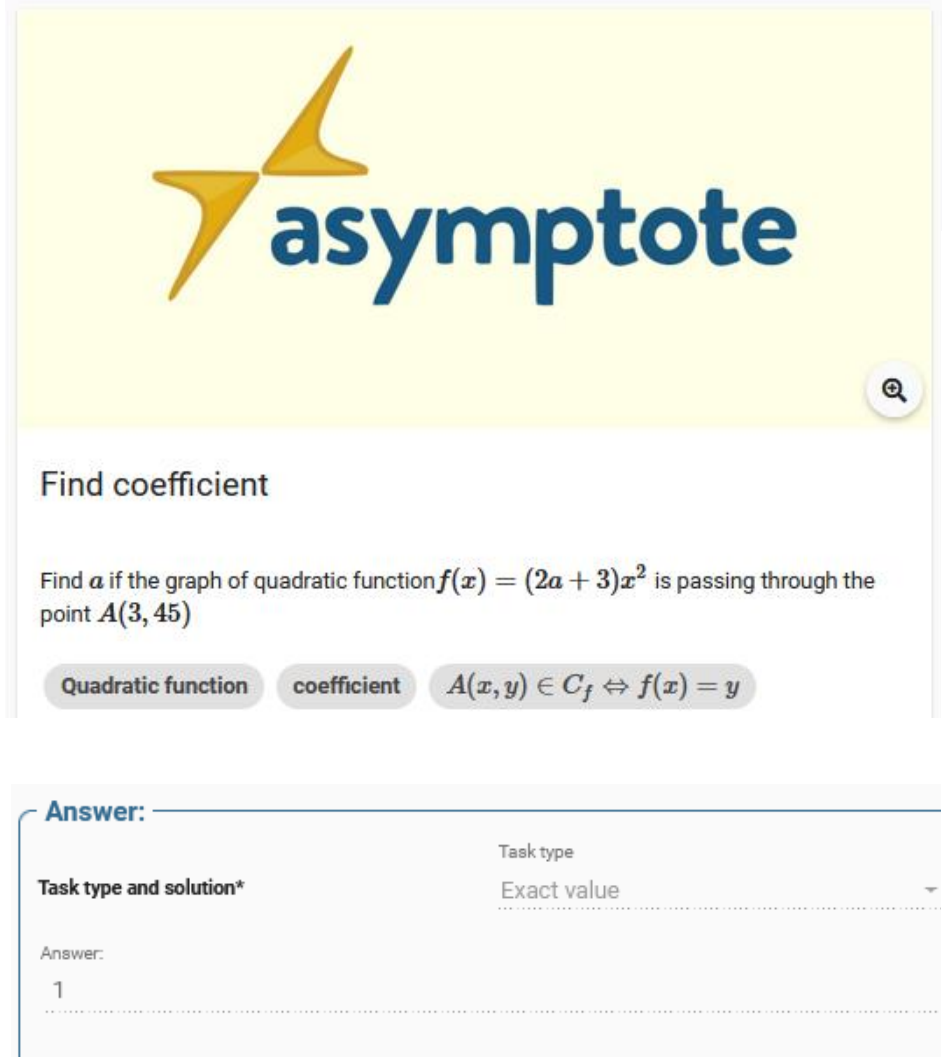
- Tasks with exact result, e.g. arithmetic problems & combinatorial problems.

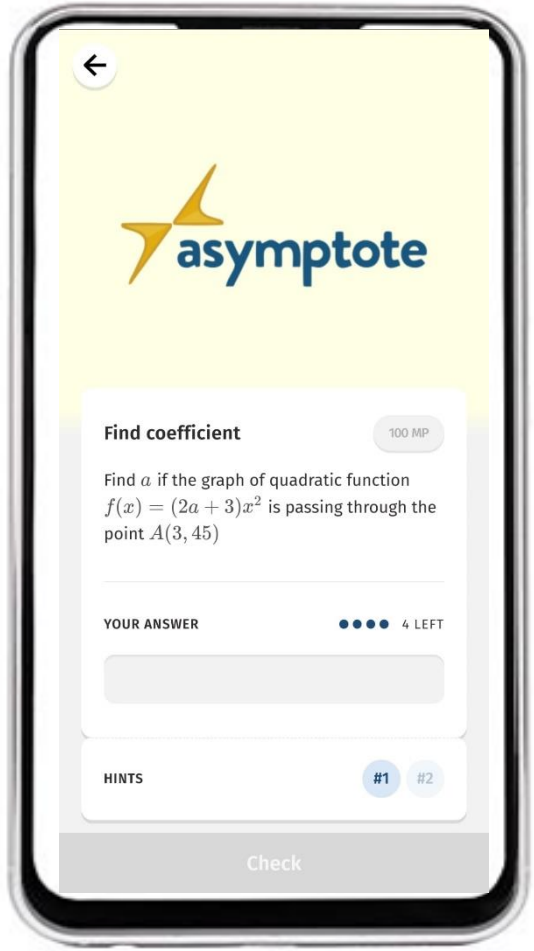
Multiple Choice

- Quiz tasks & query true/false statements

Fill in the Blanks

- Tasks for learning technical terms and language





Interval

- Tasks that require some latitude, e.g., modeling & estimating.

Exact value

- Tasks with exact result, e.g. arithmetic problems & combinatorial problems.

Multiple Choice

- Quiz tasks & query true/false or irrational results.

Fill in the Blanks

- Tasks for learning technical terms and language

Tabletennis

The Chinese tabletennis player Ma Long is famous for his balloon defense. In one case, he make a ballon defense with 3.8 m height and a range of 10.6 m.
The flight path can be described by $f(x) = -0.14x^2 + 3.8$
Cross all correct answers for this description.

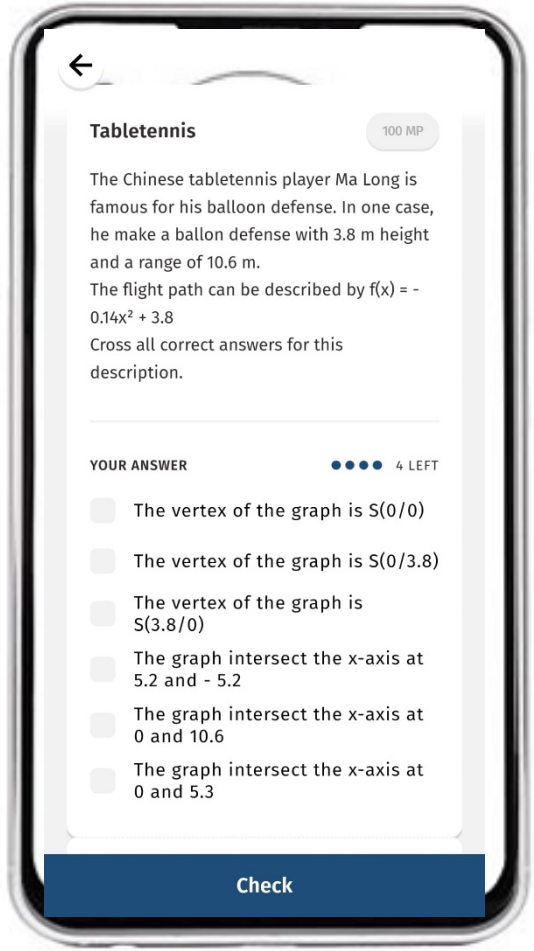
term | quadratic function

Answer:

Task type and solution*

Task type: Multiple Choice

- [ ] The vertex of the graph is S(0/0)
- [x] The vertex of the graph is S(0/3.8)
- [ ] The vertex of the graph is S(3.8/0)
- [x] The graph intersect the x-axis at 5.2 and - 5.2
- [ ] The graph intersect the x-axis at 0 and 10.6
- [ ] The graph intersect the x-axis at 0 and 5.3



Interval

- Tasks that require some latitude, e.g., modeling & estimating.

Exact value

- Tasks with exact result, e.g. arithmetic problems & combinatorial problems.

Multiple Choice

- Quiz tasks & true/false statement query

Fill in the Blanks

- Tasks for learning technical terms and language

Law of gravity

The Italian Galileo Galilei discovered the law of gravity. The distance s in meters that a body falls in t seconds is approximately $s = 5\,t^2$.
He verified his law on the Pisa Sharp Tower, which is 54 m high (see picture).
a.) How long does the stone fall from the top to the bottom?
b.)From what height do you have to drop a stone so that it reaches the ground in 2s?

Round to 2 decimal places.

Pisa | law of gravity

Answer:

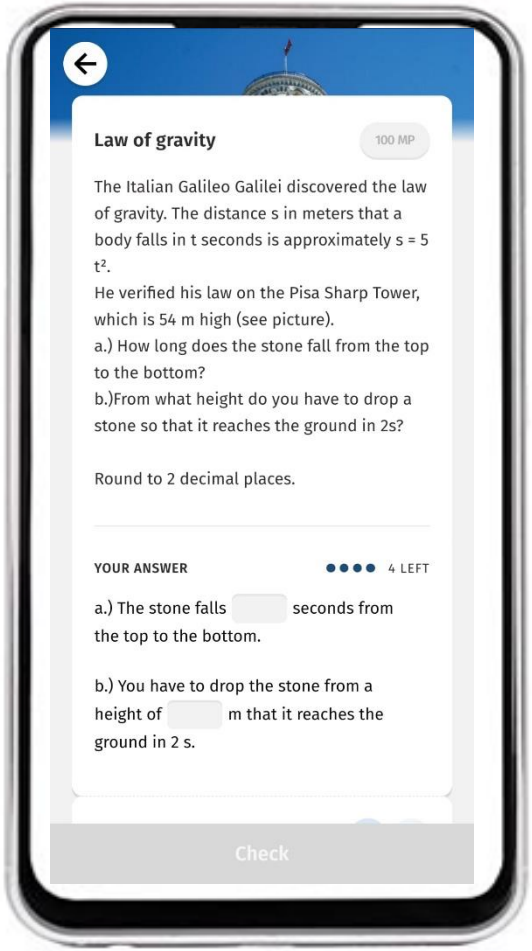
Task type and solution*

Task type: Fill in the Blanks

Fill in the Blanks

a.) The stone falls **3,29/3.29/3,28/3.28** seconds from the top to the bottom.

b.) You have to drop the stone from a height of **20** m that it reaches the ground in 2 s.



Vector (Interval and Exact Value)

- Tasks with solutions from several ordered components (multidimensional extension of the formats interval and exact value)

Set

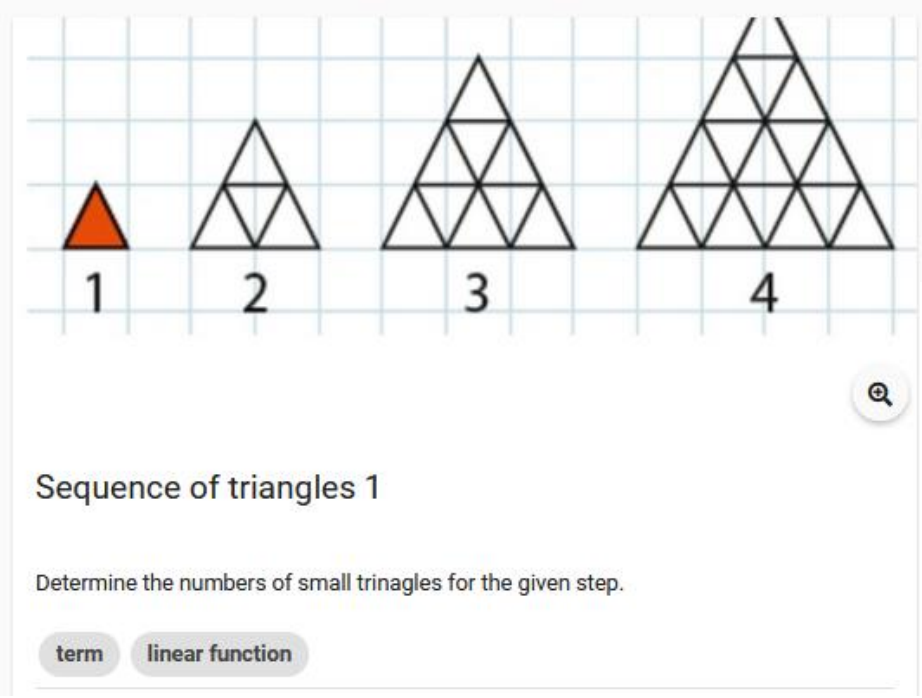
- Tasks with solution from several unordered components

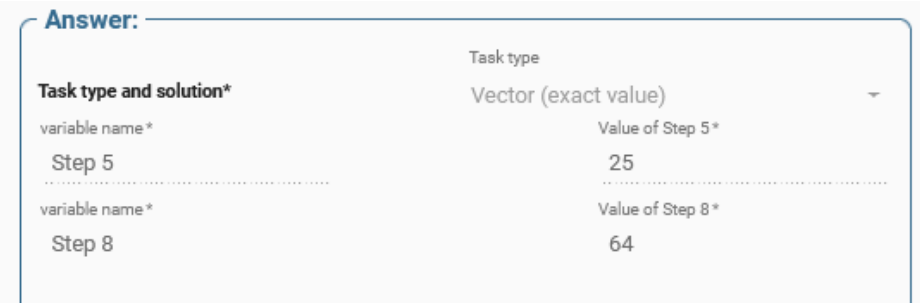
Fraction

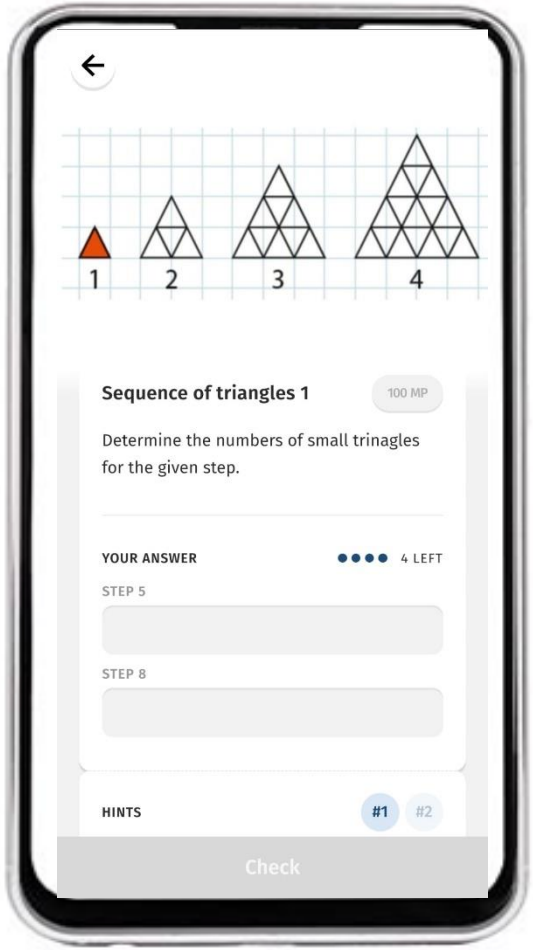
- Tasks with real or mixed fractions

Information station

- Possibility to introduce facts (without task and solution input) or to set research tasks







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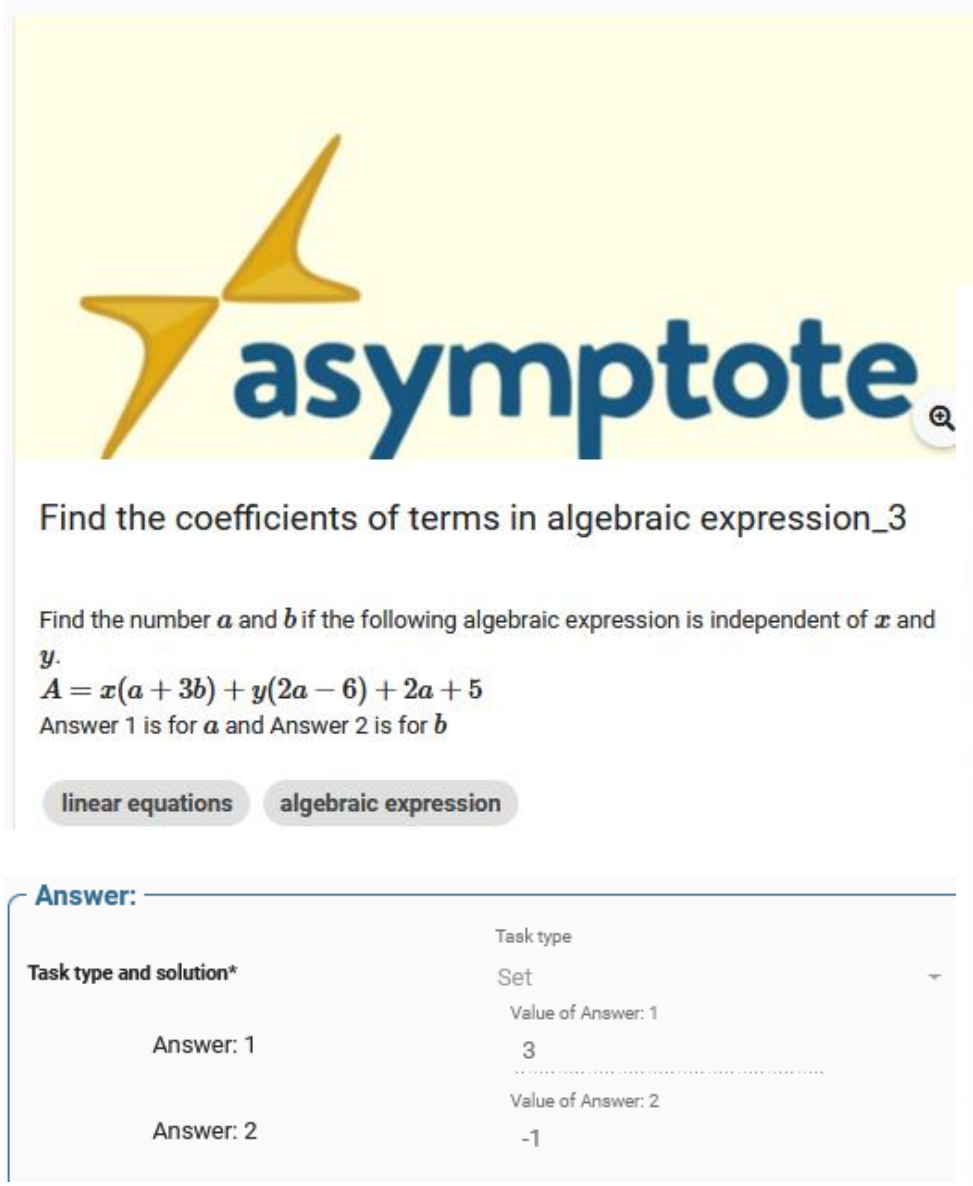

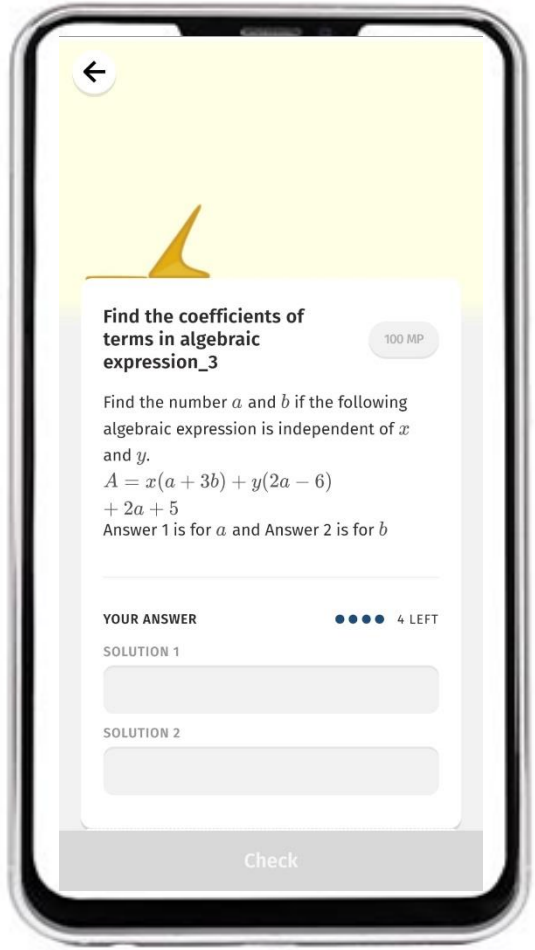

Vector (Interval and Exact Value)

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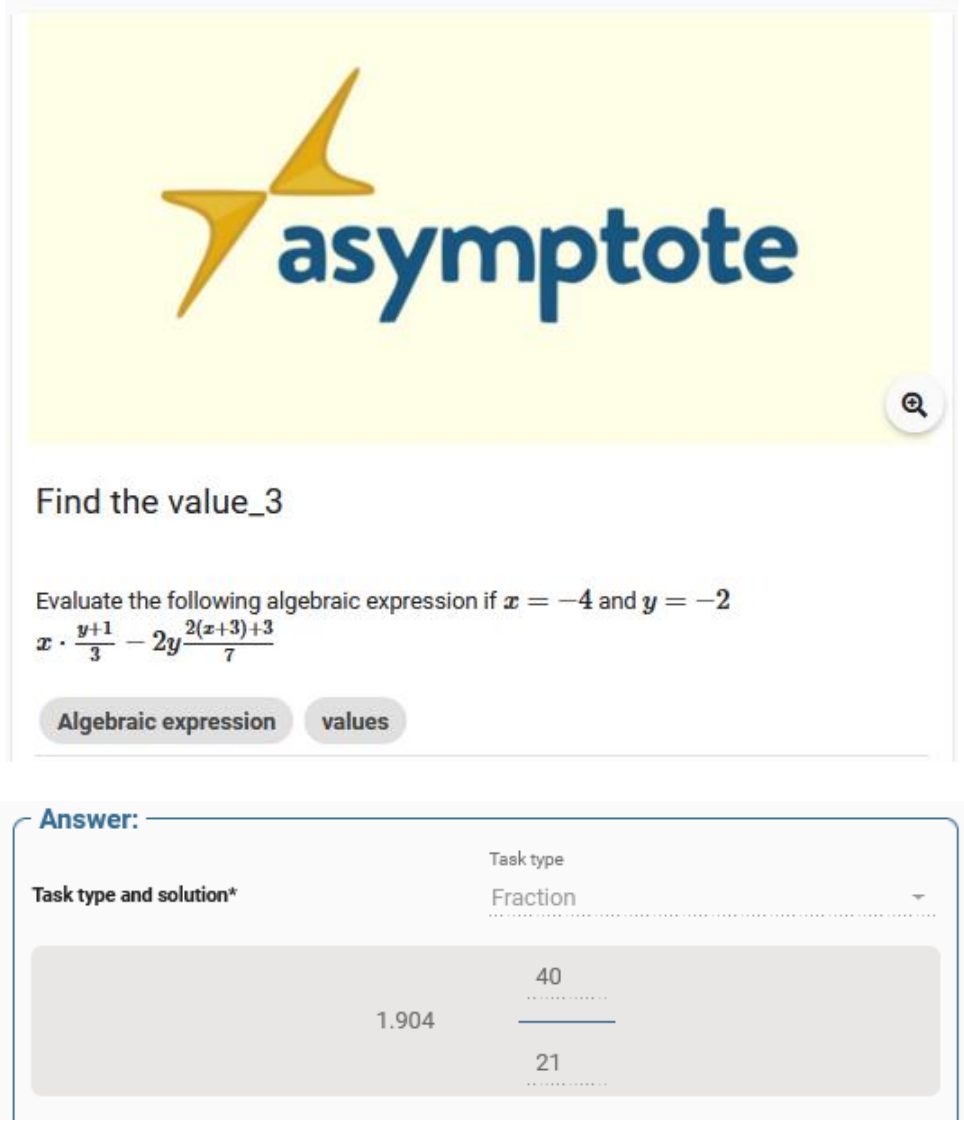
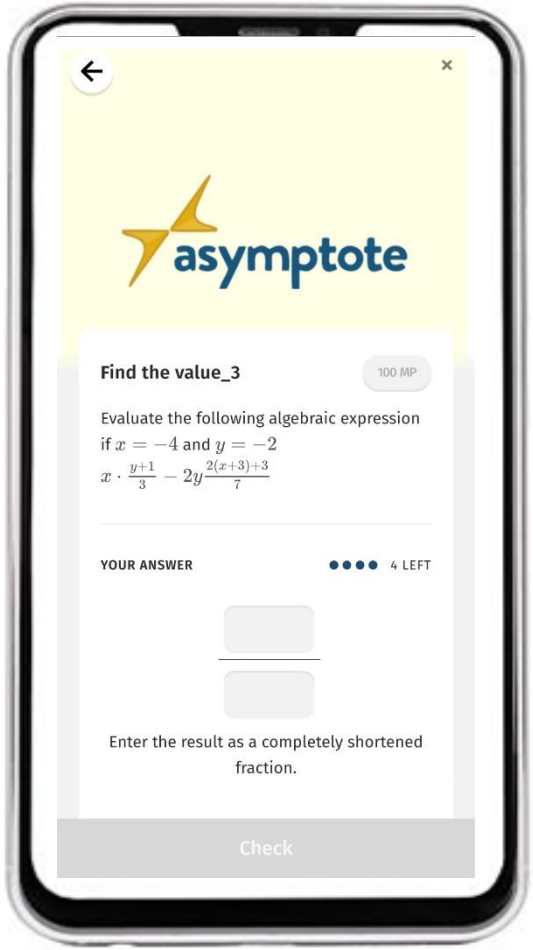
- Possibility to introduce facts (without task and solution input) or to set research tasks





Vector (Interval and Exact Value)

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Set

- Tasks with solution from several unordered components

Fraction

- Tasks with real or mixed fractions

Information station

- Possibility to introduce facts (without task and solution input) or to set research tasks

ASYMPTOTE Web Portal

6.7 Creation of Learning Graphs

Web Portal Functionalities

The ASYMPTOTE Web Portal offers the possibility …

1. to select digital tasks and adaptive learning graphs from an open database
2. to make own tasks and graphs available to other users
   - by sharing own tasks and graphs with groups
   - by making them publicly available for all users
3. **to create own** tasks and **learning graphs**
4. to monitor student's working progress in the Digital Classroom

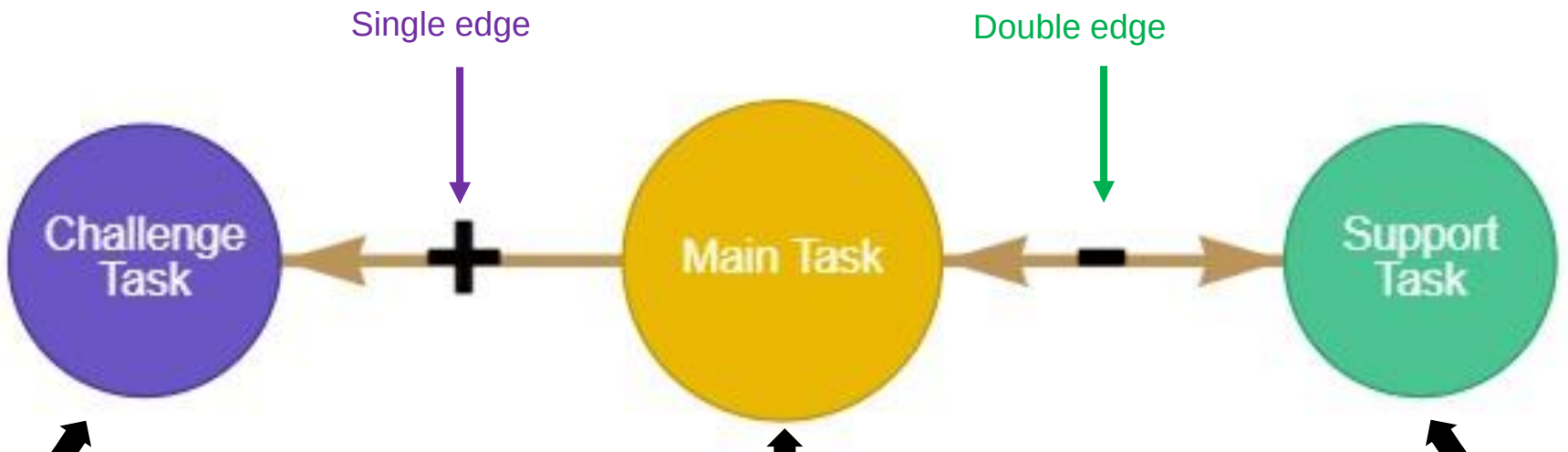
Overview

Let´s create a learning graph!

Guiding in the learning process, organizing tasks in order to achieve success in learning.

1. One learning graph level for each subject to learn
2. Example of a learning graph
3. How to create a learning graph in ASYMPTOTE web portal

One learning graph level for each subject to learn



Task level	Task category	Task level	Task category	Task level	Task category
• Expert	• Reasoning • Modeling	• Intermediate	• Training • Reasoning	• Beginner	• Learning • Training

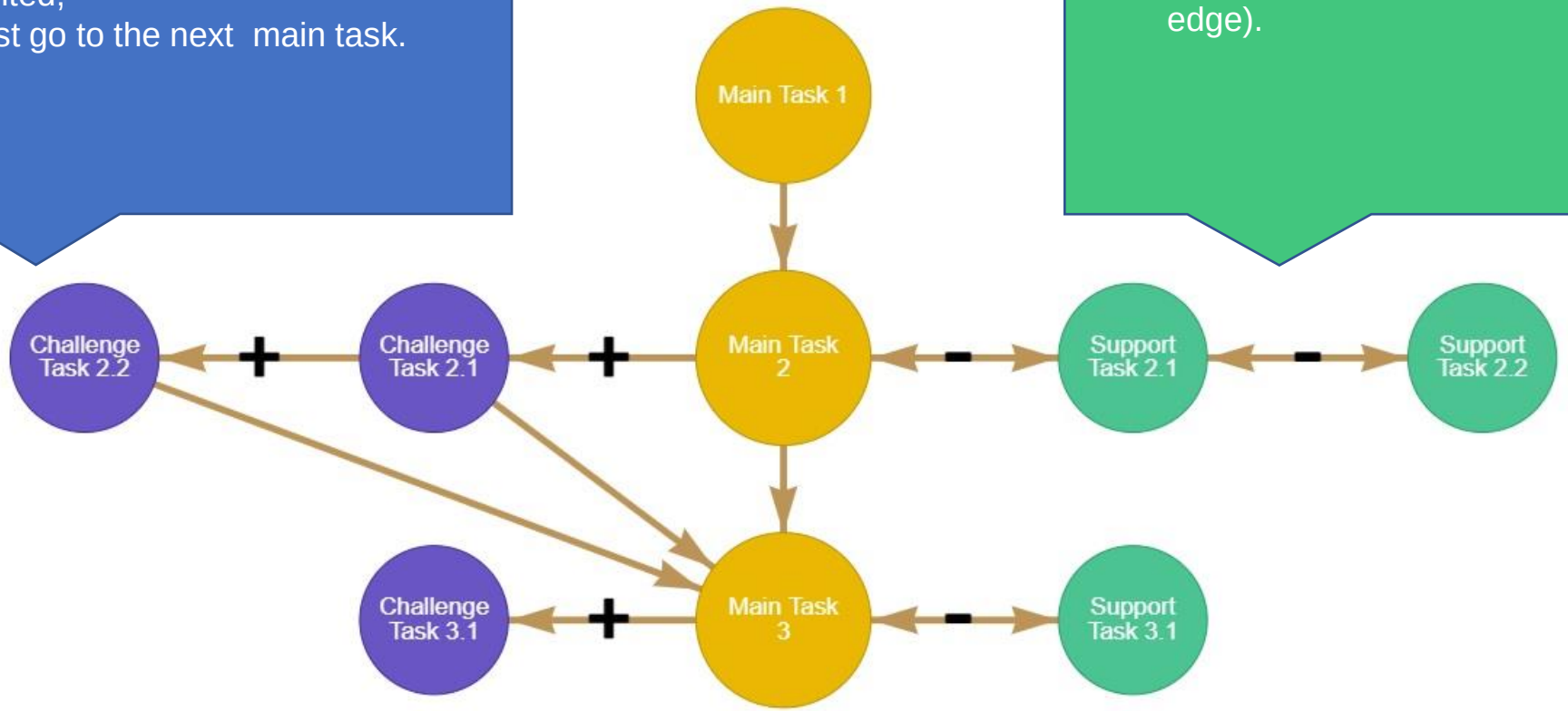
This level can be replicated for each learning subject.

Example of a learning graph

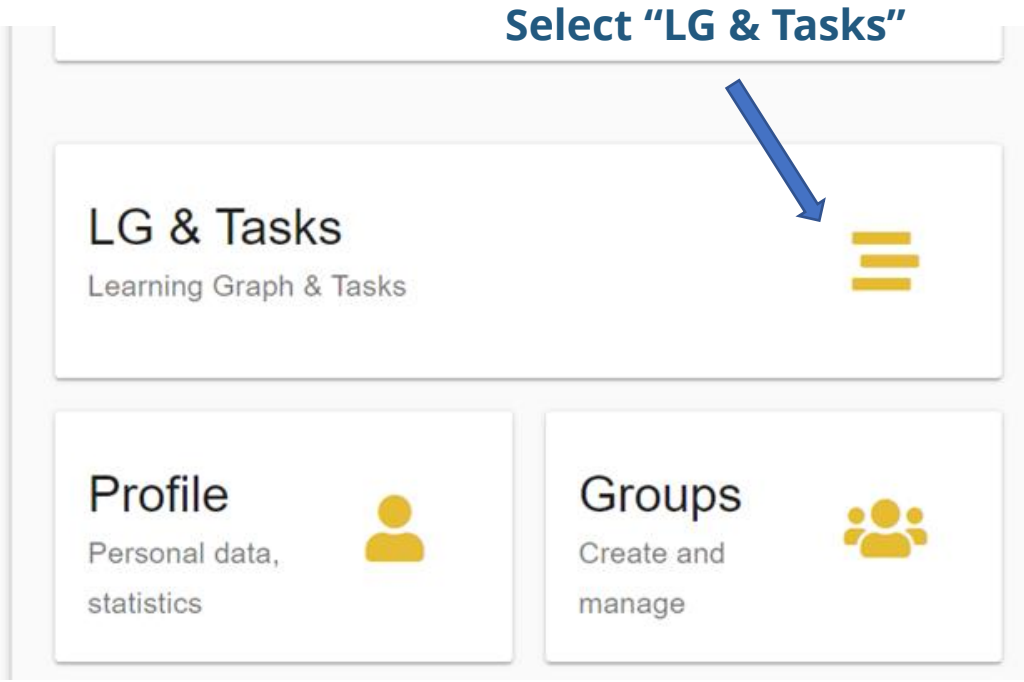
- Prompt to access after solving the main task;
- Number of challenger tasks as wanted;
- Must go to the next main task.

Mandatory

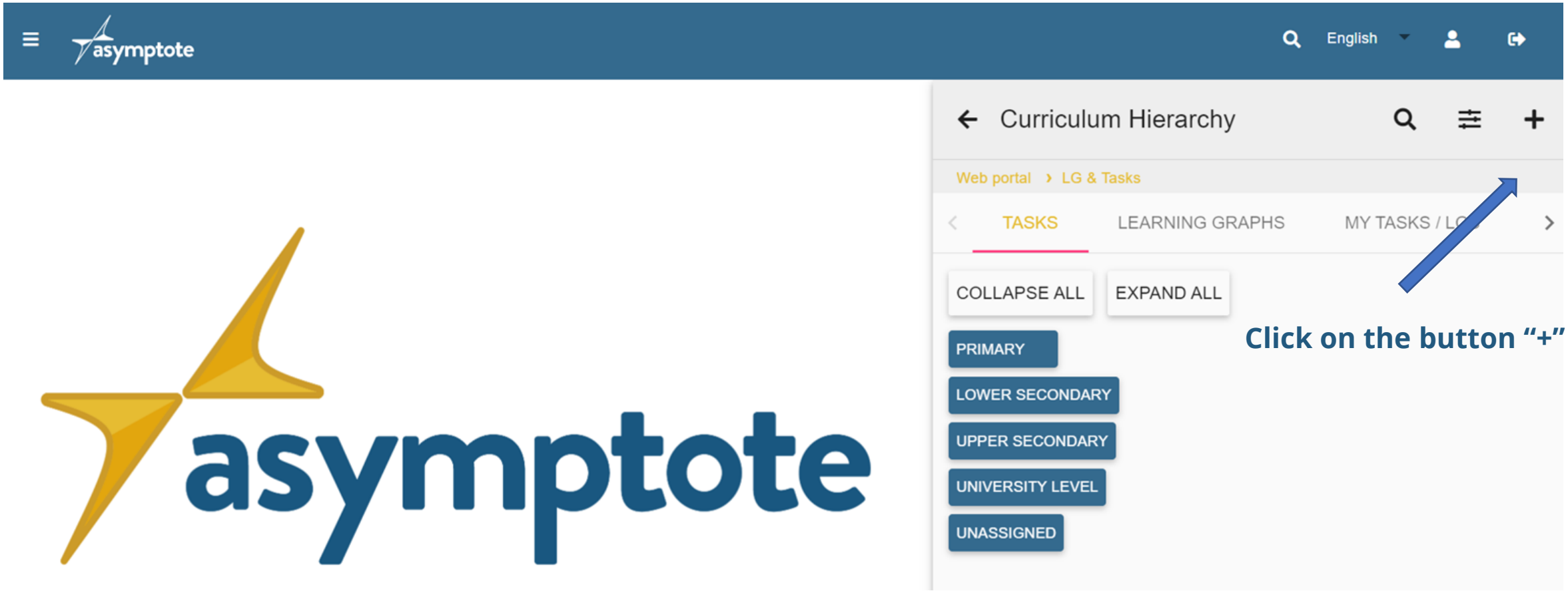
- Prompt to access after 2nd incorrect entry on the main task;
- Number of support tasks as needed;
- Must return to the main task (double edge).



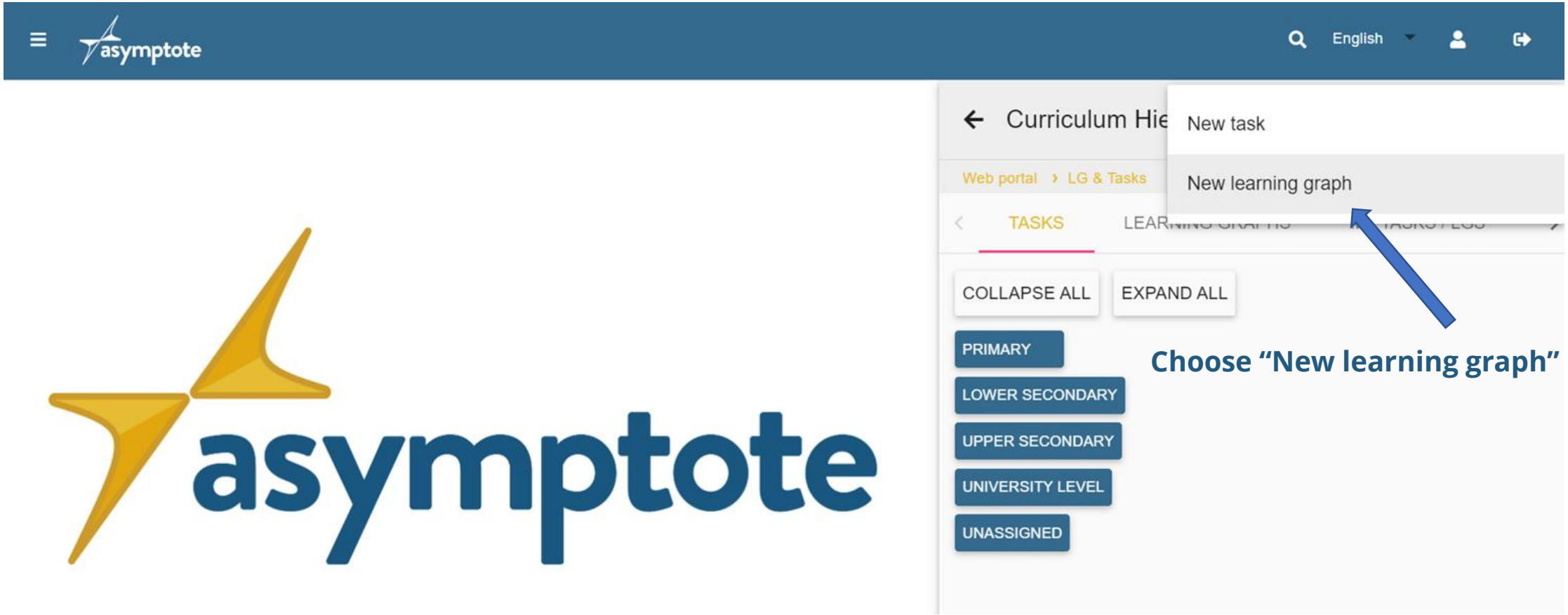
How to create a learning graph in ASYMPTOTE web portal



How to create a learning graph in ASYMPTOTE web portal



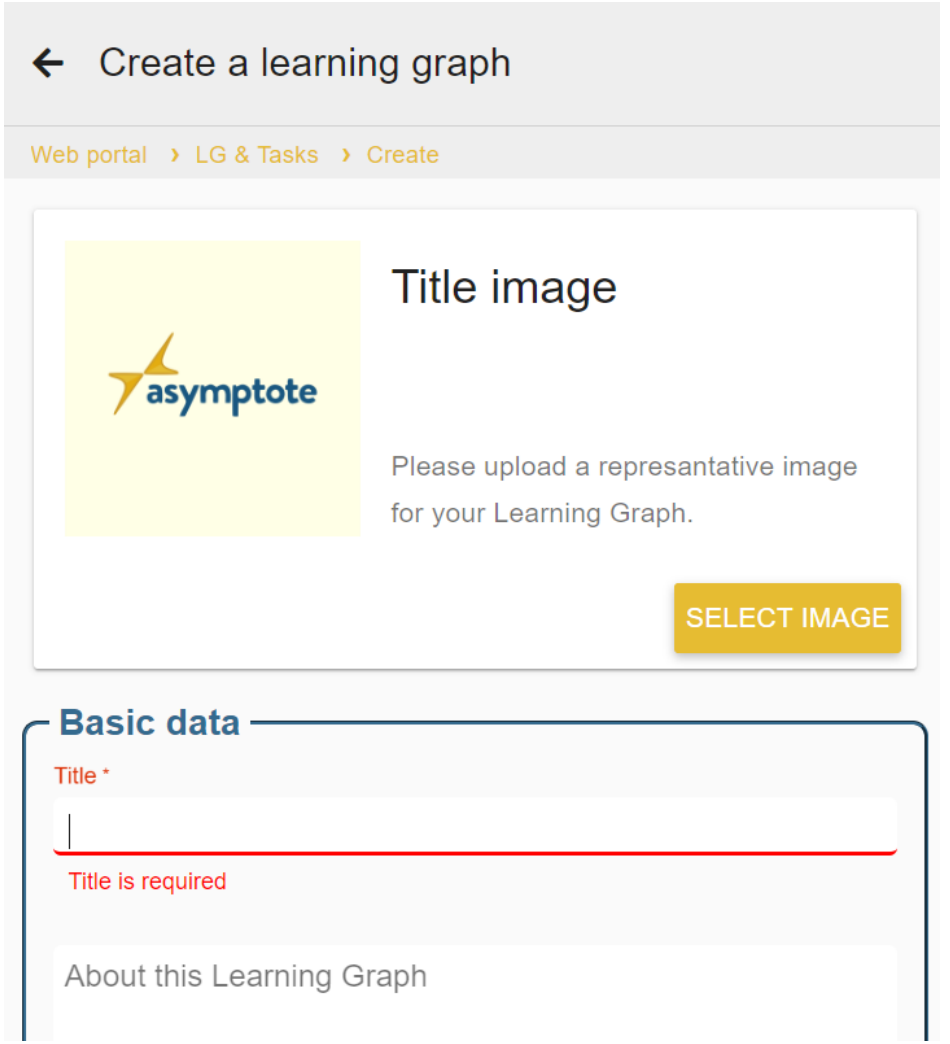
How to create a learning graph in ASYMPTOTE web portal



How to create a learning graph in ASYMPTOTE web portal

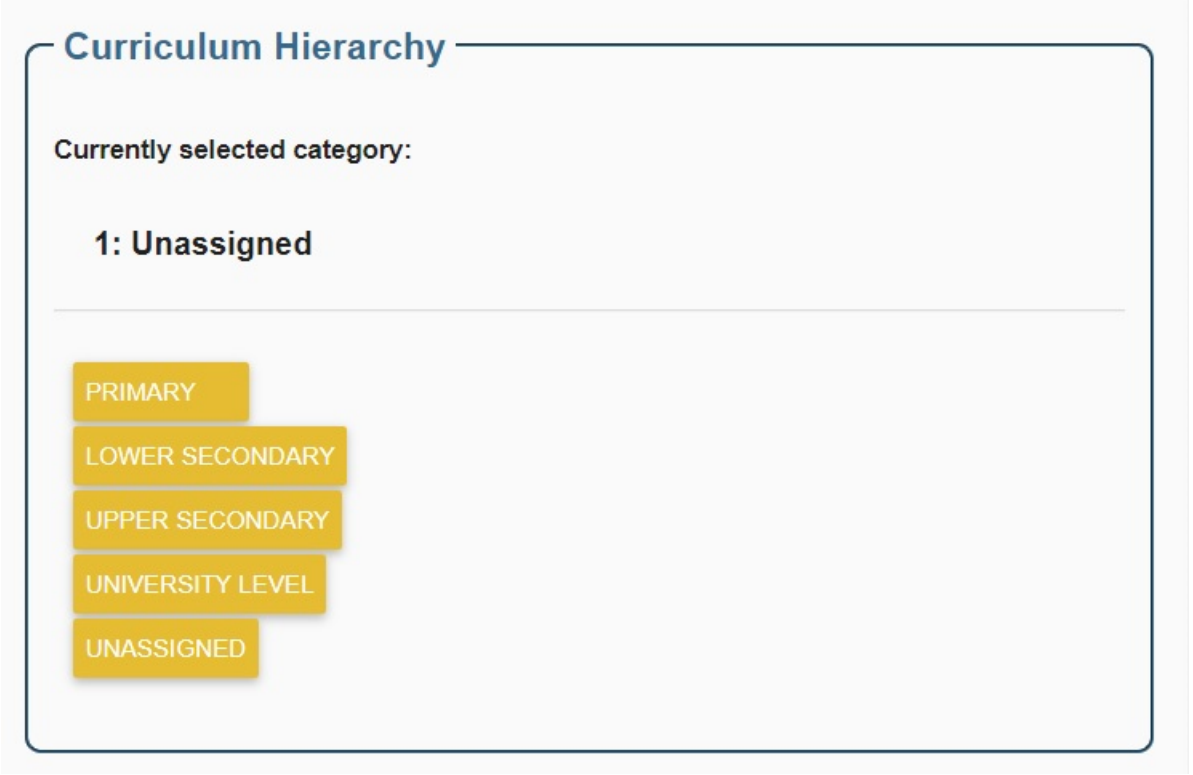
Fill the form:

- The image is optional
- The learning graph must have a title and a description



How to create a learning graph in ASYMPTOTE web portal

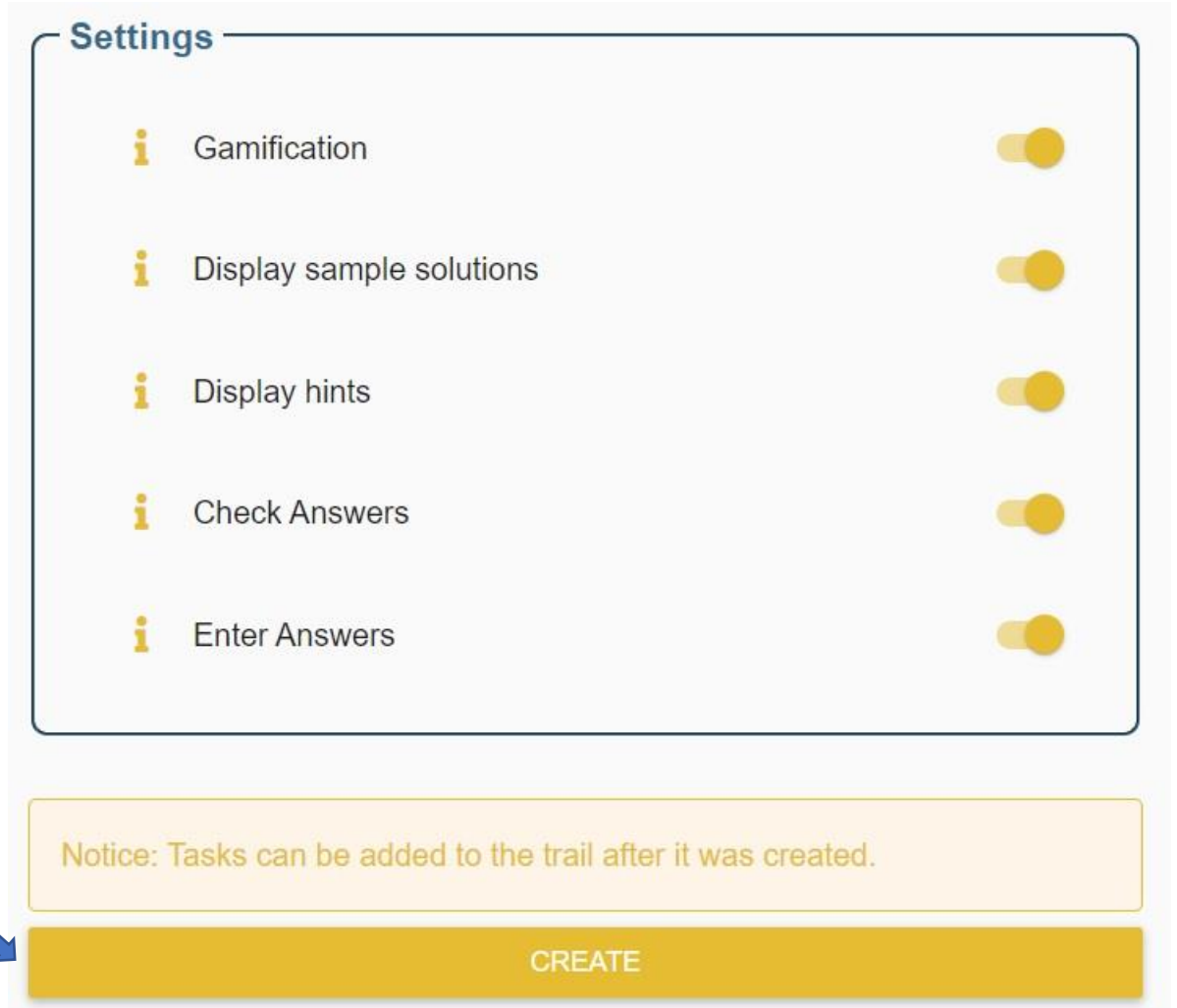
- Learning graphs must be assigned to a curricular topic, e.g. linear functions



How to create a learning graph in ASYMPTOTE web portal

The tasks, previously created, will be added to the learning graph after it was created.

After filling out the form select “create”

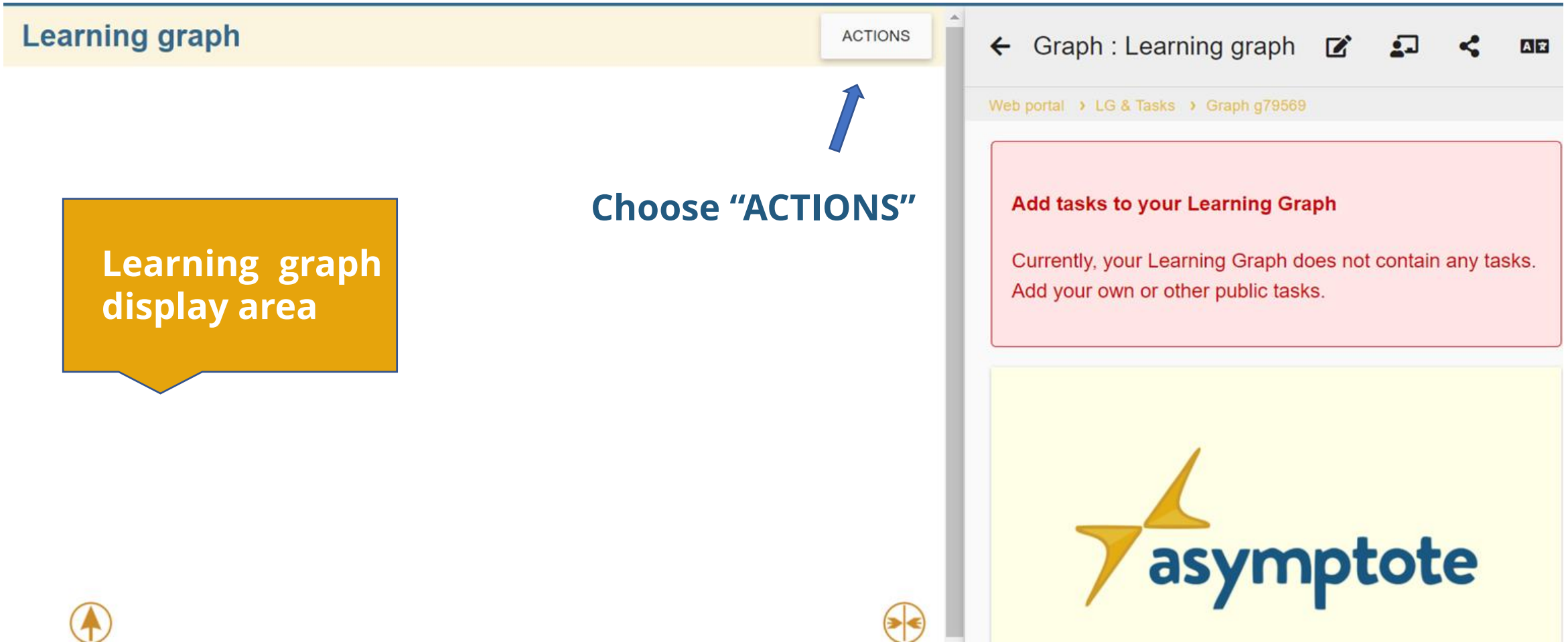


How to create a learning graph in ASYMPTOTE web portal

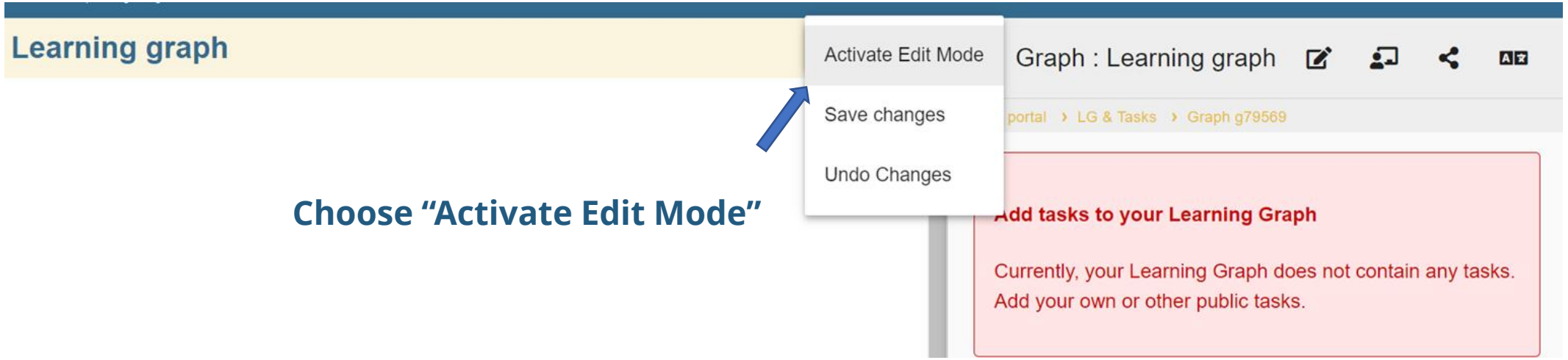
After creating a task, you can edit it

Share the task with a group

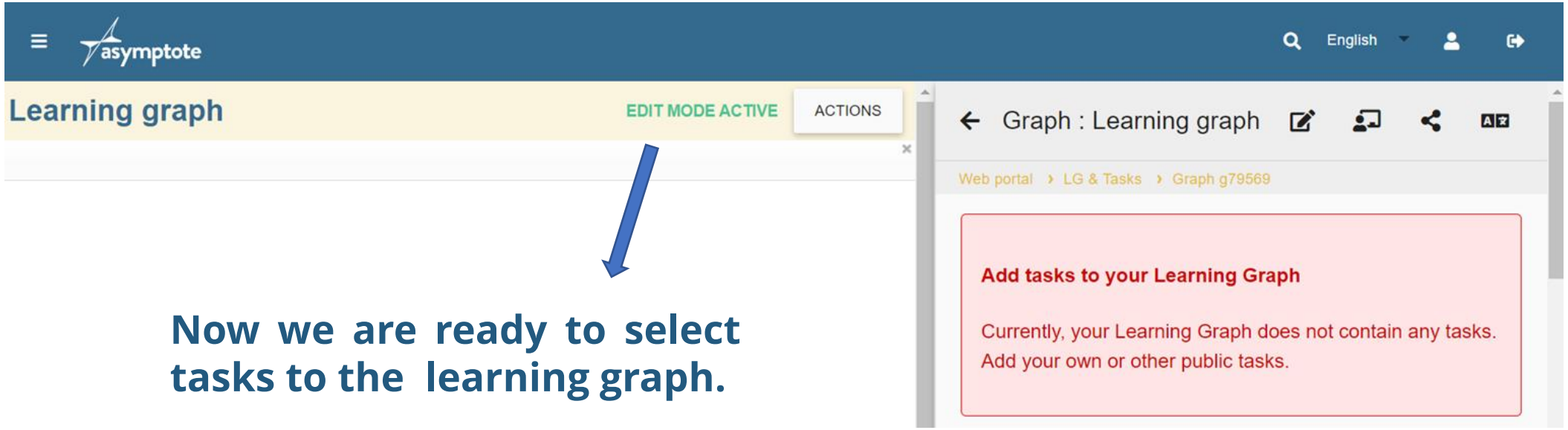
How to create a learning graph in ASYMPTOTE web portal



How to create a learning graph in ASYMPTOTE web portal

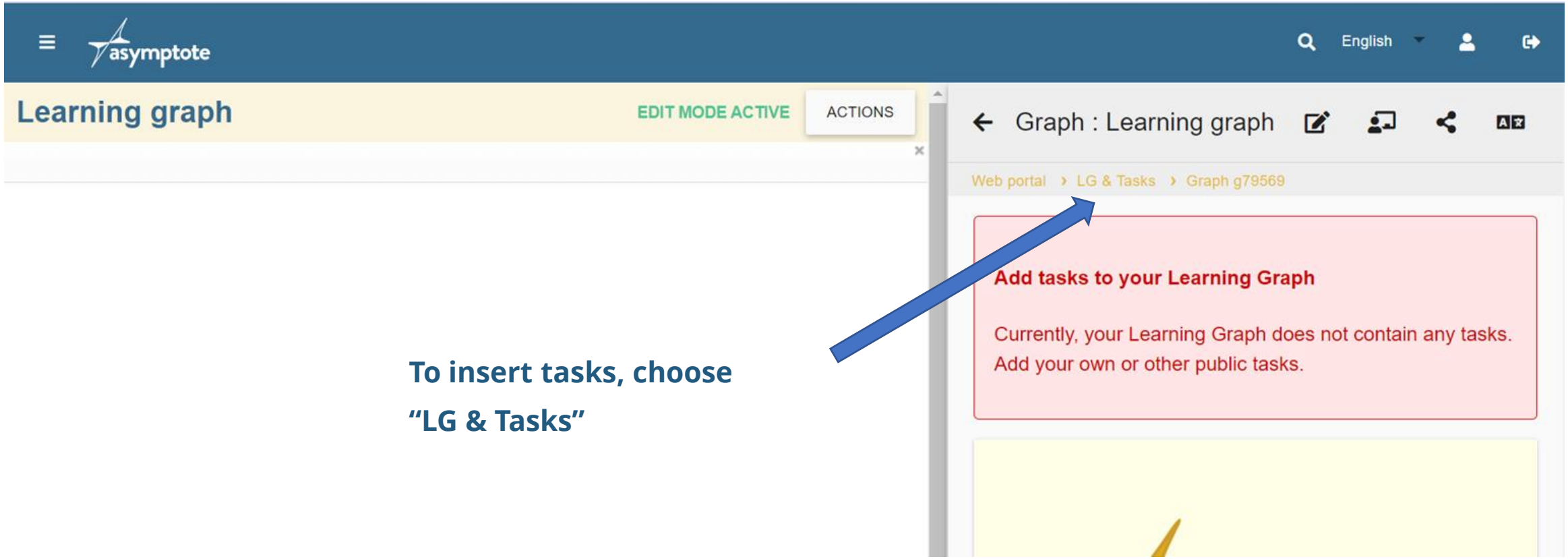


Choose “Activate Edit Mode”



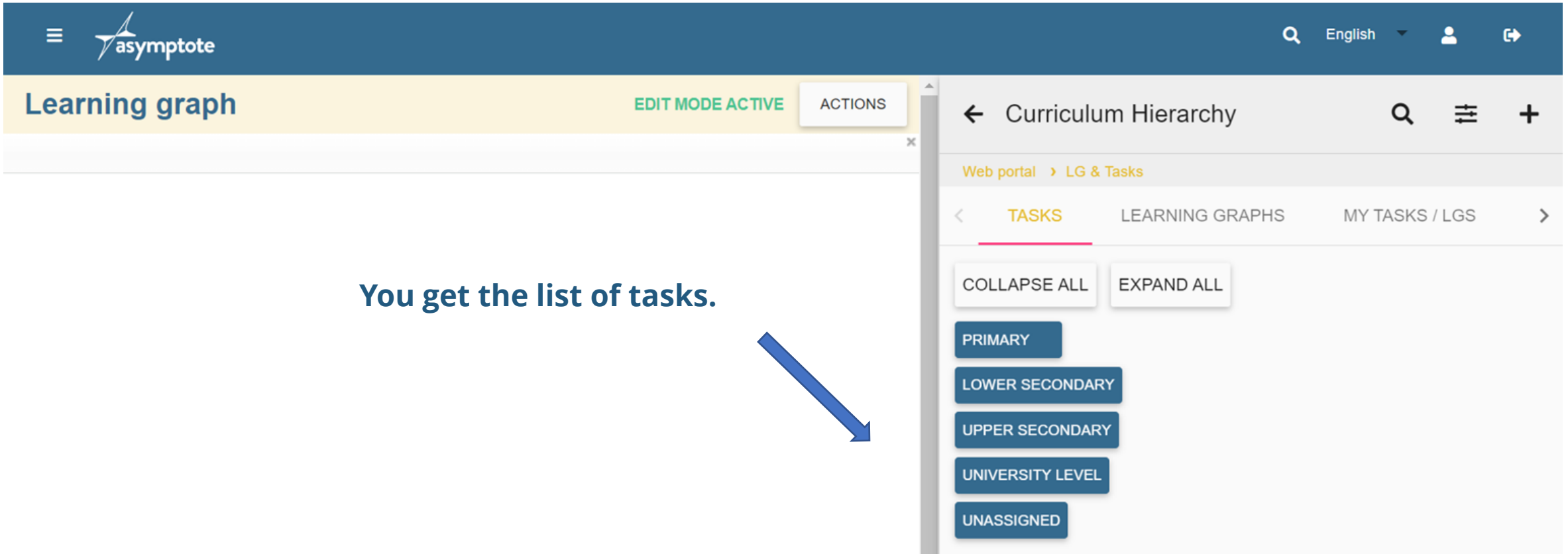
Now we are ready to select tasks to the learning graph.

How to create a learning graph in ASYMPTOTE web portal



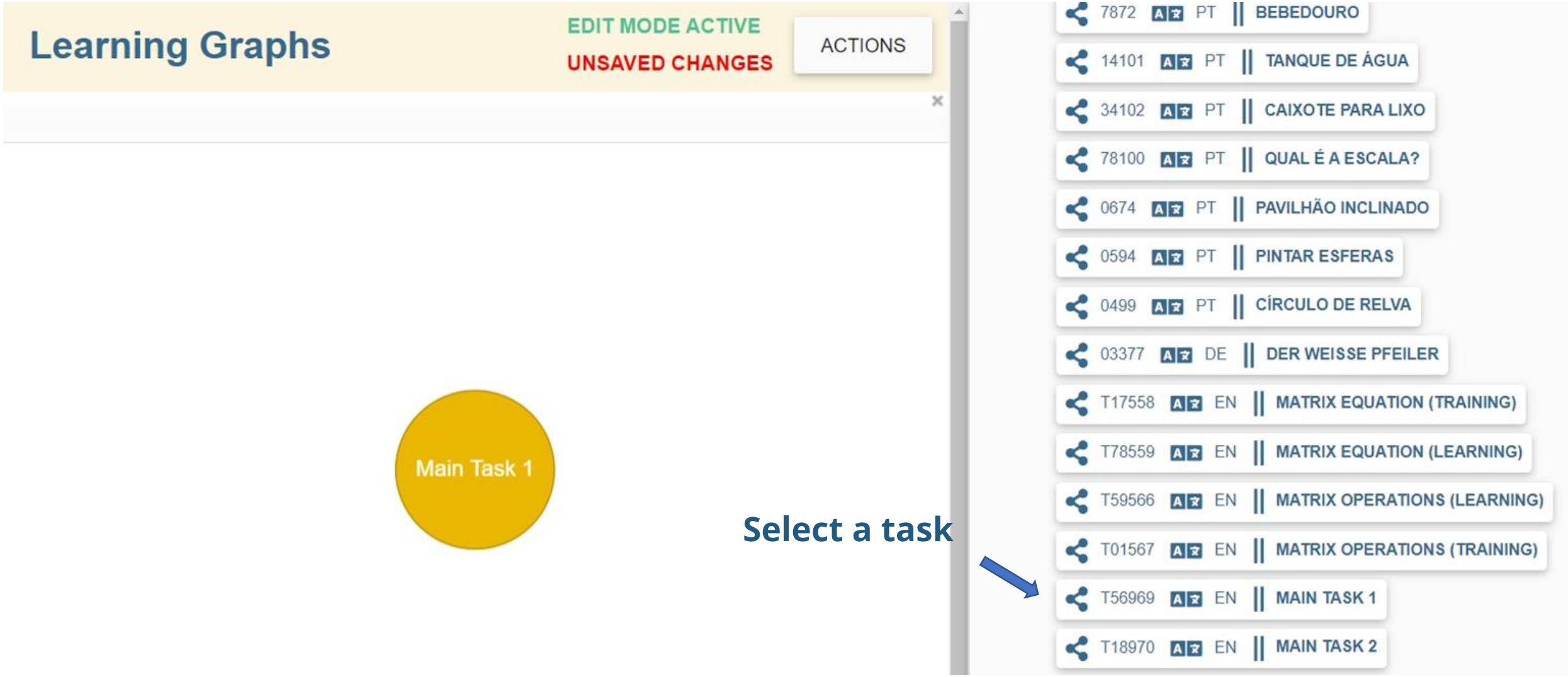
To insert tasks, choose “LG & Tasks”

How to create a learning graph in ASYMPTOTE web portal

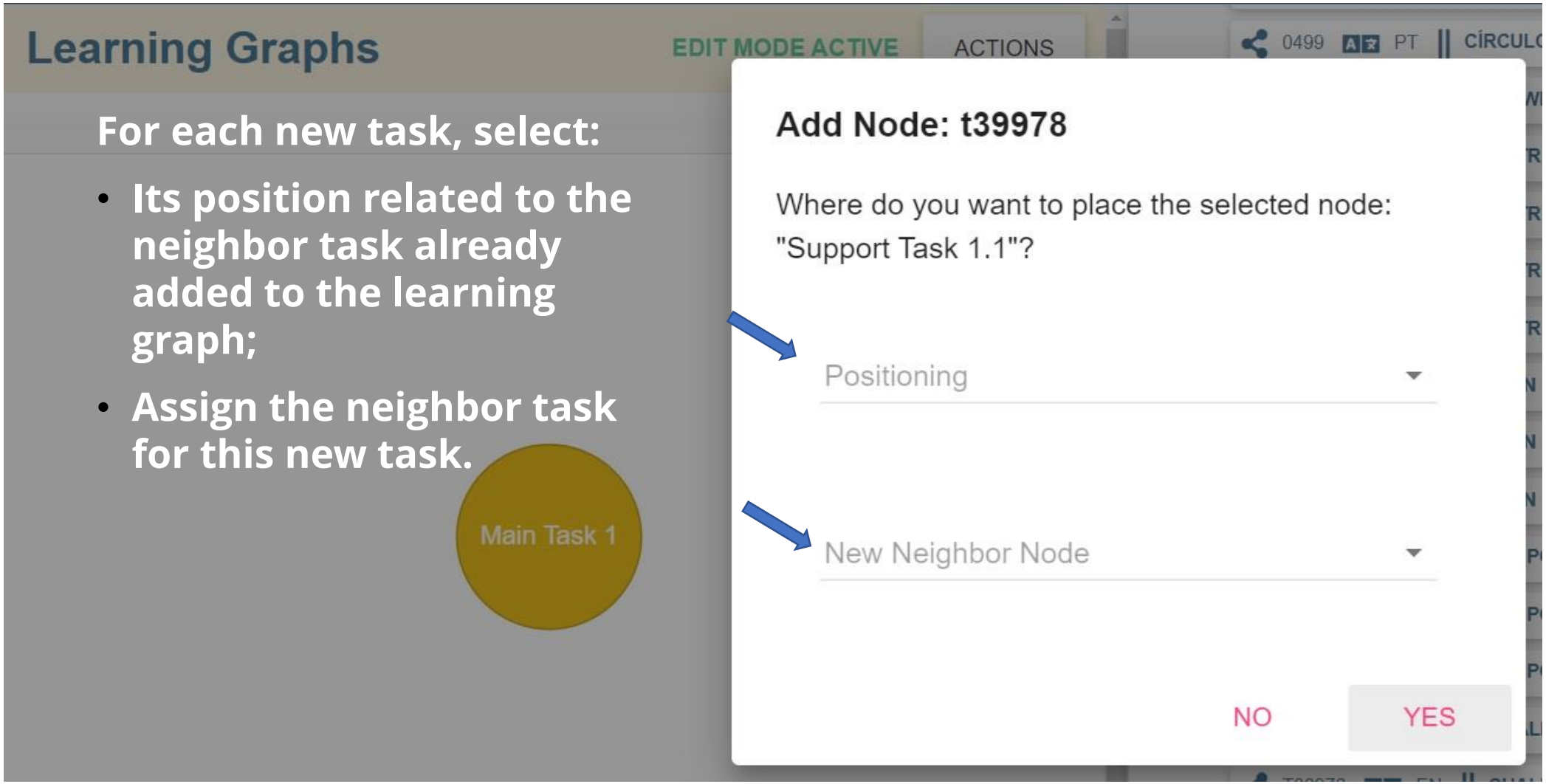


You get the list of tasks.

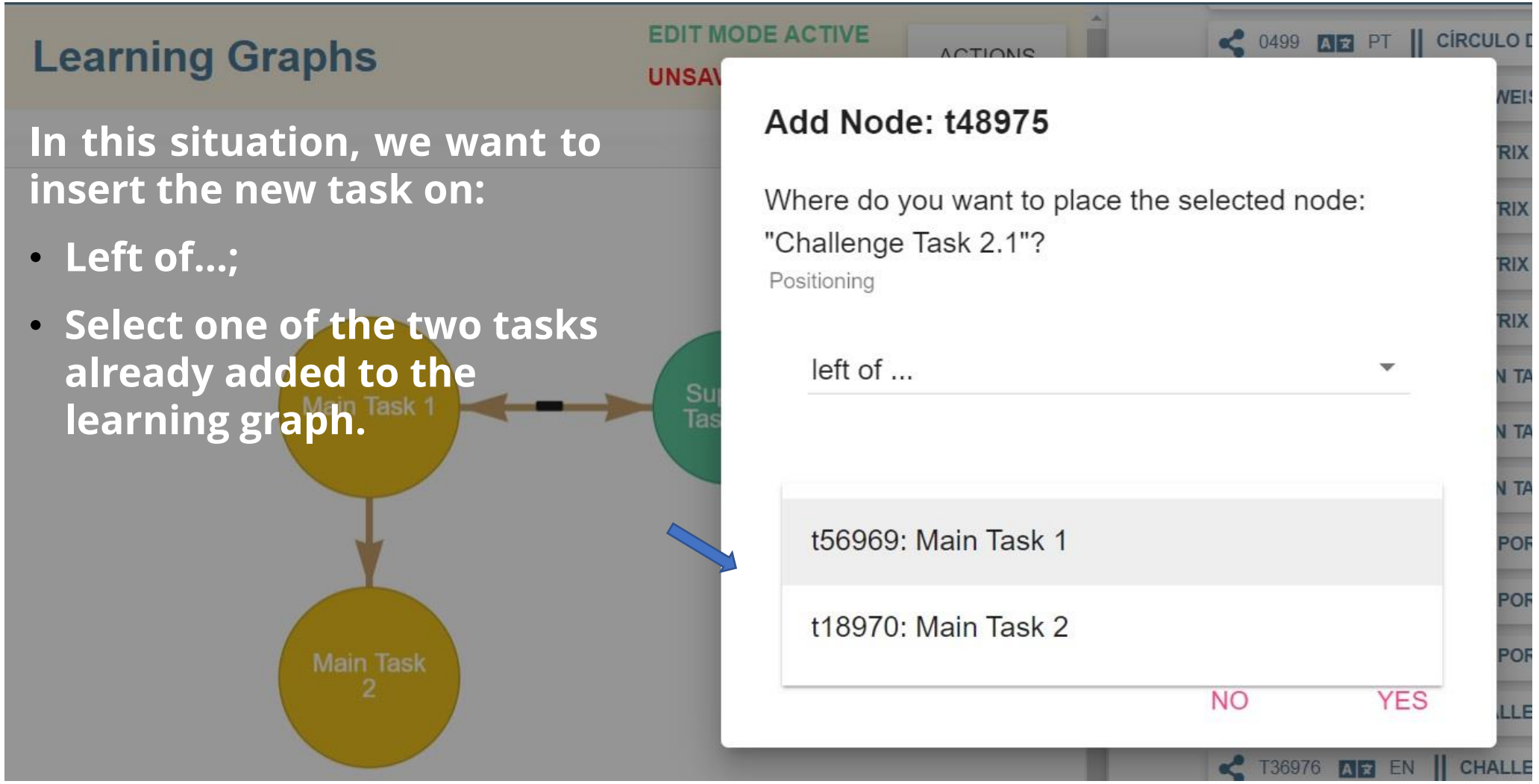
How to create a learning graph in ASYMPTOTE web portal



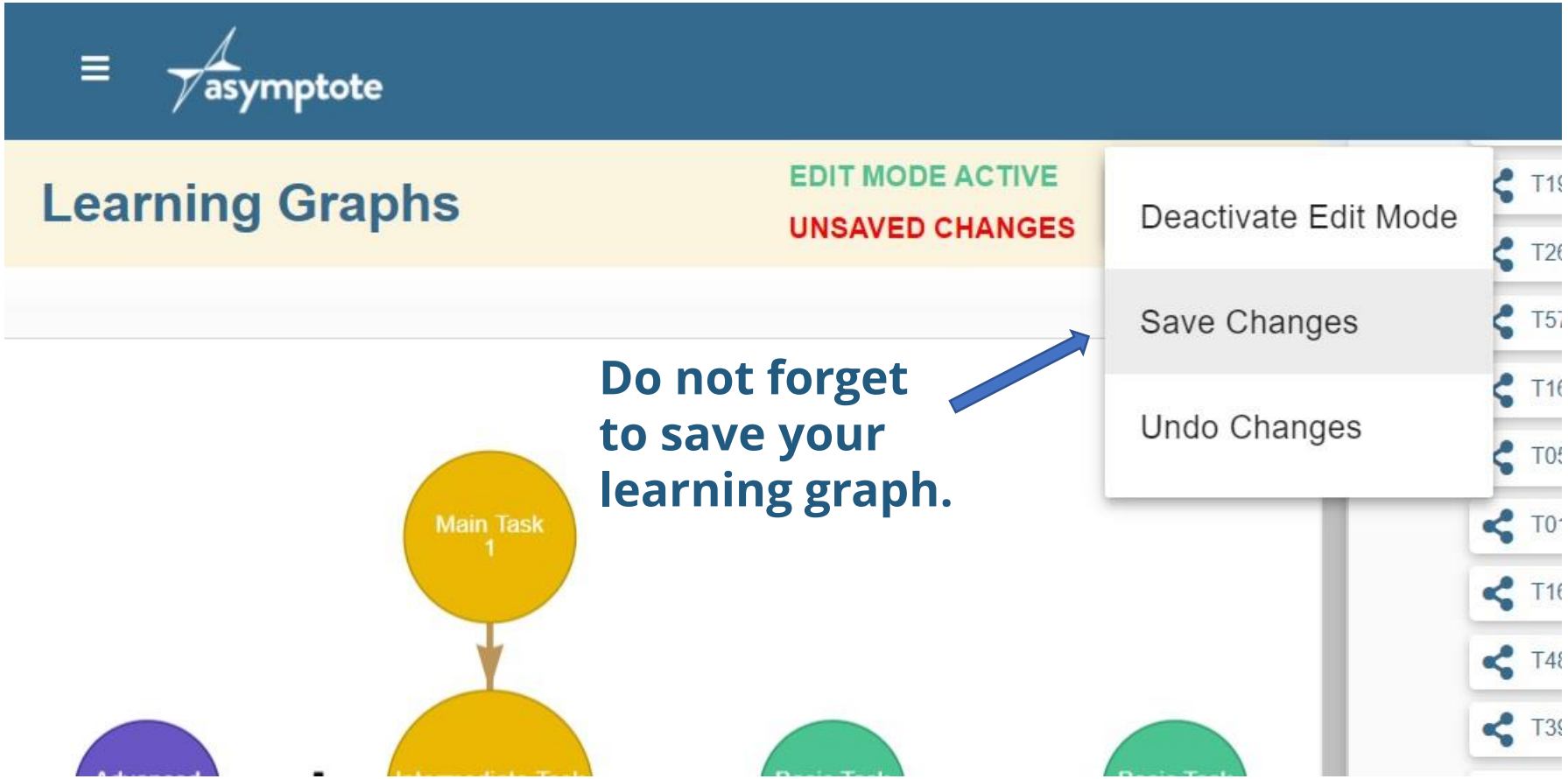
How to create a learning graph in ASYMPTOTE web portal



How to create a learning graph in ASYMPTOTE web portal



How to create a learning graph in ASYMPTOTE web portal



ASYMPTOTE Web Portal

7. The Digital Classroom

Web Portal Functionalities

The ASYMPTOTE Web Portal offers the possibility …

1. to select digital tasks and adaptive learning graphs from an open database
2. to make own tasks and graphs available to other users
   - by sharing own tasks and graphs with groups
   - by making them publicly available for all users
3. to create own tasks and learning graphs
4. **to monitor student's working progress in the Digital Classroom**

The Digital Classroom

Features of the Digital Classroom:

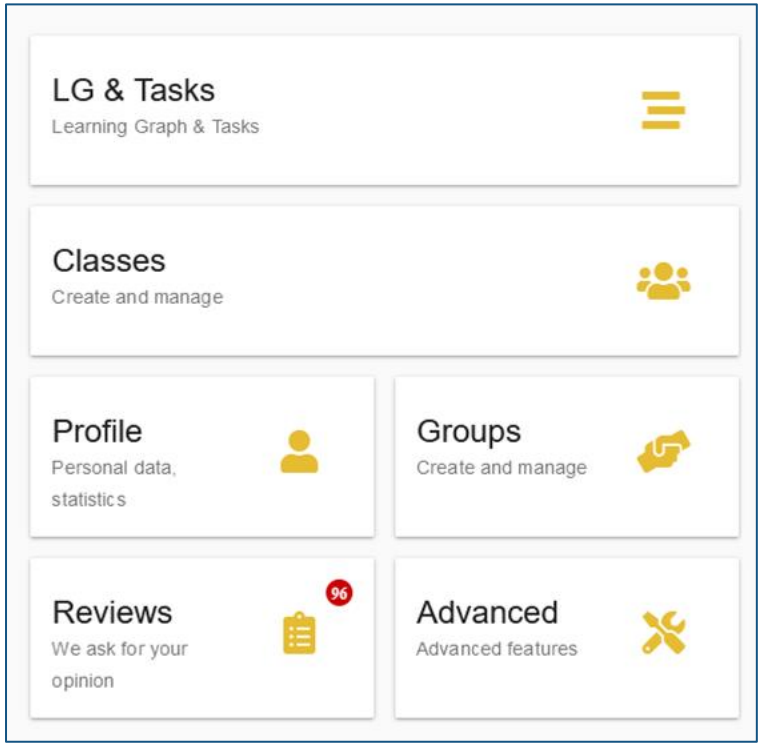
- Virtual representation of the class
- Allocation of learning graphs to students
- Real-time monitoring of student‘s work process
- Student-teacher interaction via chat
- Evaluation on individual & class level

Note: To use the Digital Classroom feature, an active internet connection is required

The Digital Classroom

Virtual representation of the class:

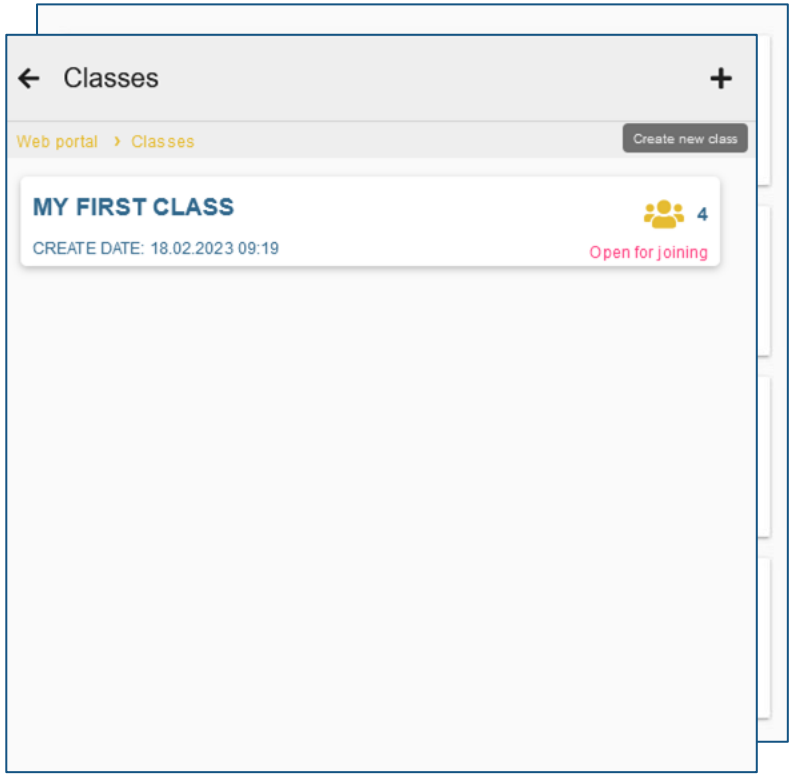
- Click on the „Classes“ button



The Digital Classroom

Virtual representation of the class:

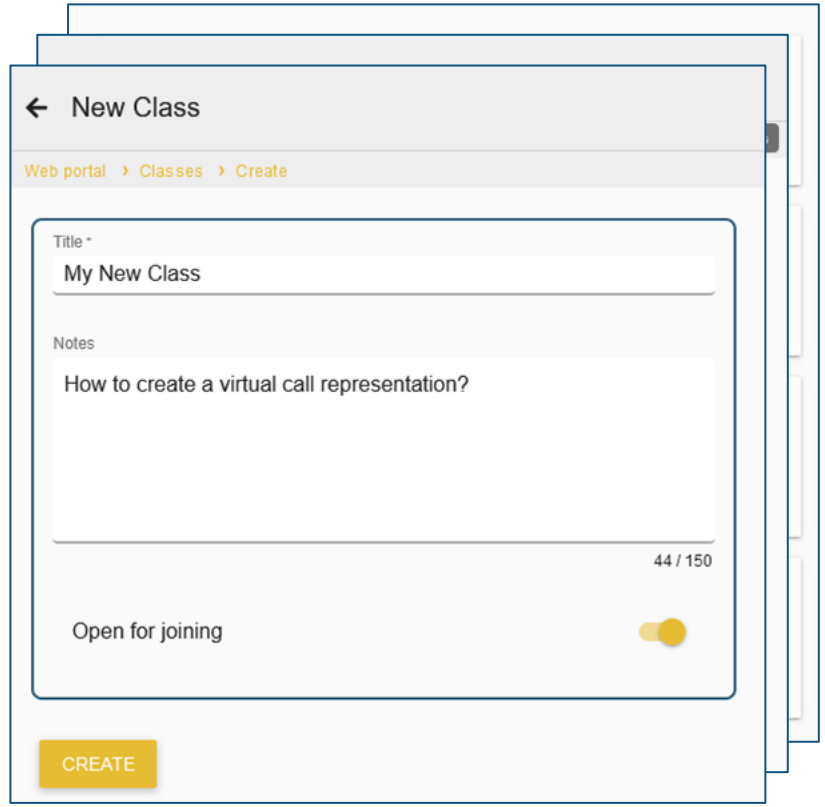
- Click on the „Classes“ button
- Click on „+“



The Digital Classroom

Virtual representation of the class:

- Click on the „Classes“ button
- Click on „+“
- Enter a title for your class & a short description
- Click on „Create“

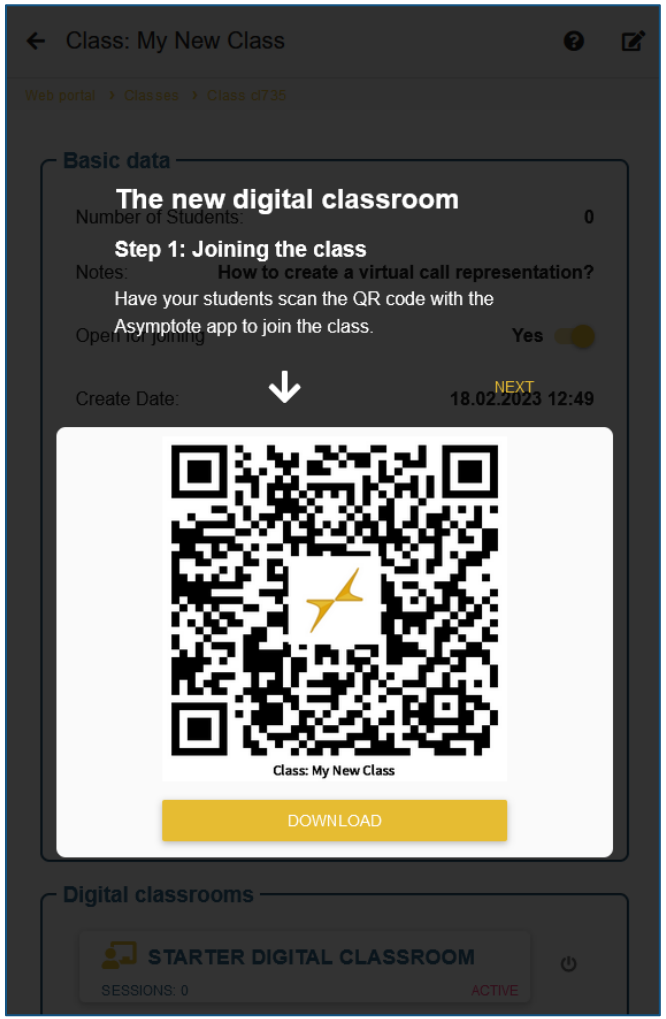


Perfect, your virtual class is set up. Now let your students join the class!

The Digital Classroom

Virtual representation of the class:

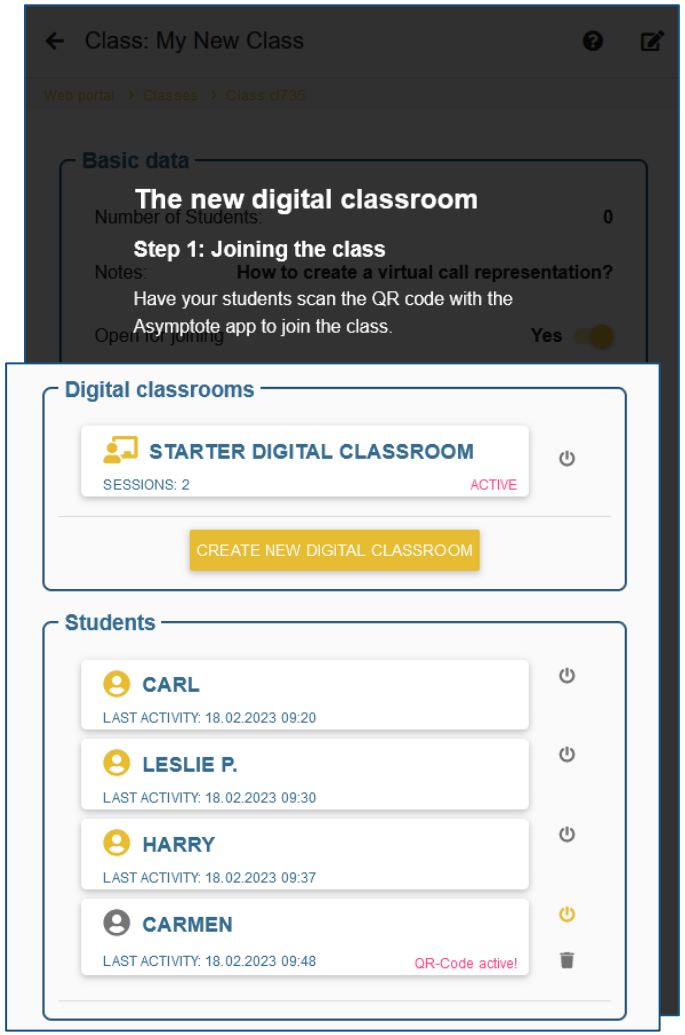
- Students can join the class via scanning the QR code once
  → No registration is needed on their side!



The Digital Classroom

Virtual representation of the class:

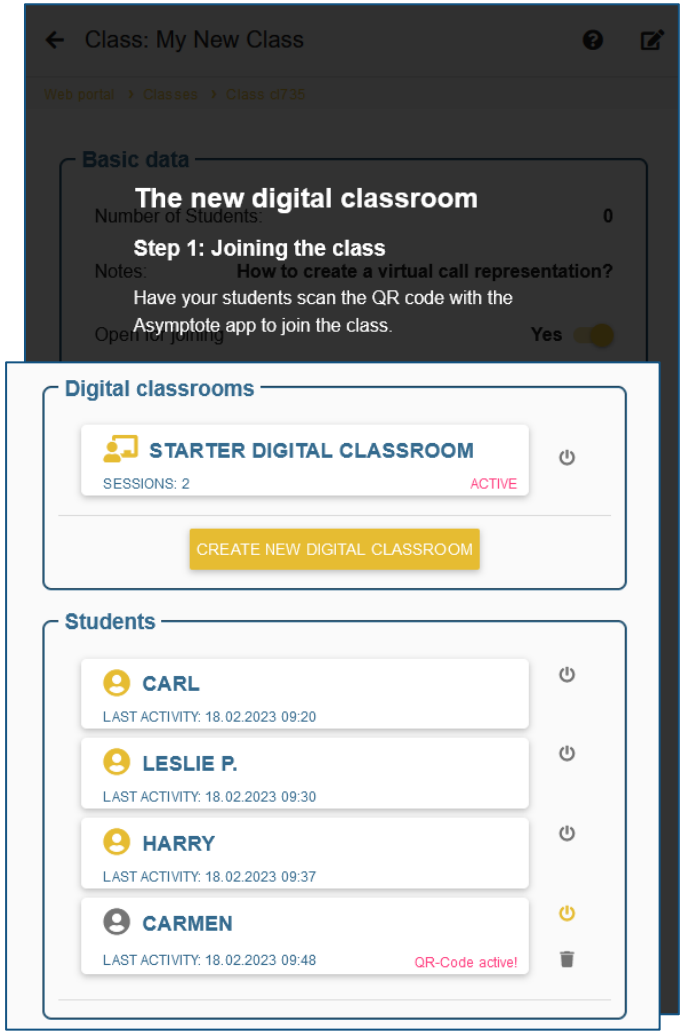
- Students can join the class via scanning the QR code once
  → No registration is needed on their side!
- Students are immediately listed in the class
  after joining



The Digital Classroom

Virtual representation of the class:

- Students can join the class via scanning the QR code once
  → No registration is needed on their side!
- Students are immediately listed in the class
  after joining
- You can change the status of a student
  - Active: student can access all allocated LG
    (see next slide; standard setting)
  - Inactive: student can view but not work on allocated LG
    (pause mode)
  - Delete: students are not longer part of the class



The Digital Classroom

Virtual representation of the class:

Reconnecting to existing work progress

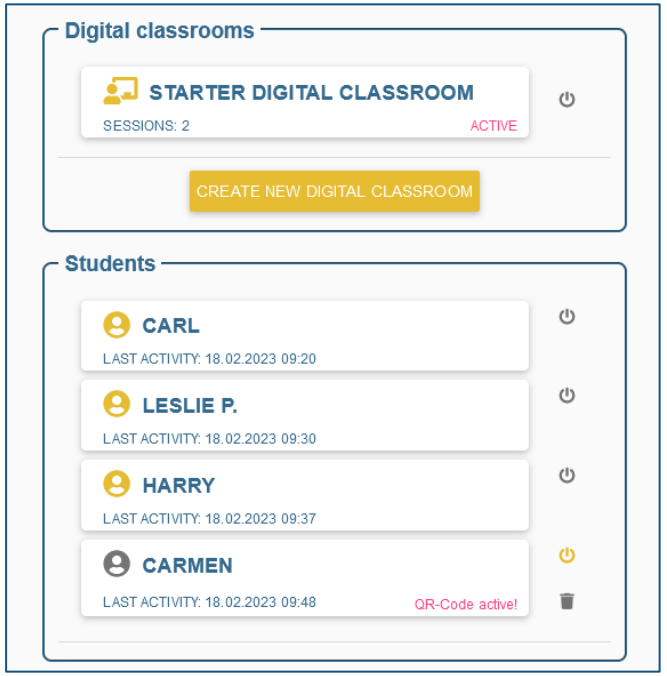
- Student‘s can reconnect to their work progress in the app after the loss/change of the mobile device or deinstallation of the app
- An individualized student QR code is activated by the teacher and scanned by the student
- As if by magic, the previous work status appears in the app!

The Digital Classroom

Virtual representation of the class:

Reconnecting to existing work progress

- Carl has a new phone. How could he reconnect to his previous work progress?
- Click on the student account of Carl



The Digital Classroom

Virtual representation of the class:

Reconnecting to existing work progress

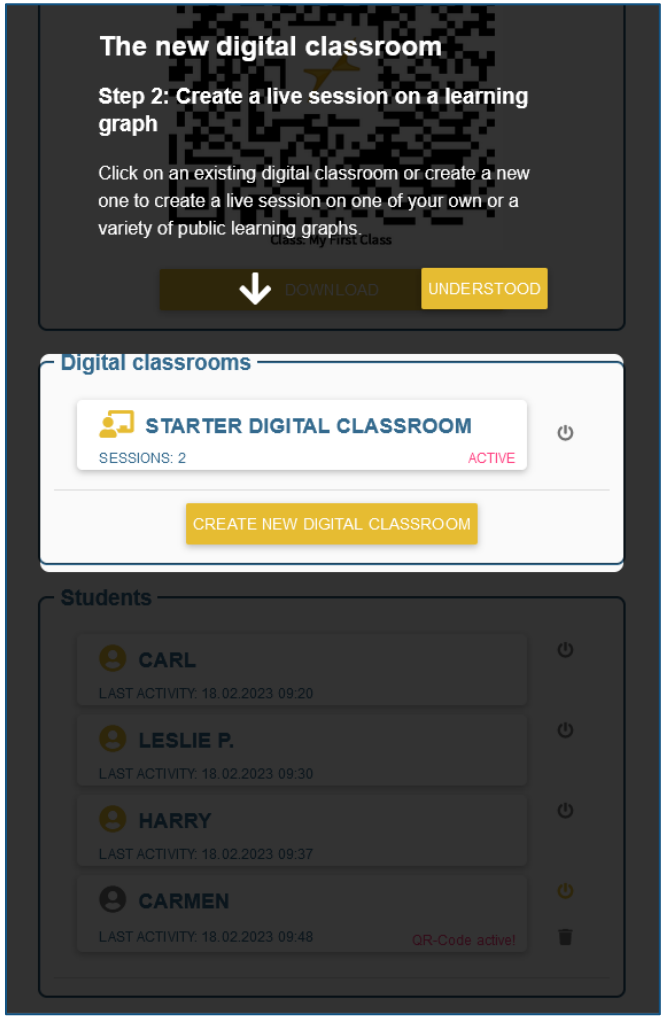
- Carl has a new phone. How could he reconnect to his previous work progress?
- Click on the student account of Carl
- Activate „Reconnection possible“
- Let Carl scan his individualized QR code
- His previous work process is automatically restored!

By clicking the „edit“ button (upright), teachers can change student‘s pseudonyms.

The Digital Classroom

Allocation of learning graphs to students:

- Click on „Starter Digital Classroom“

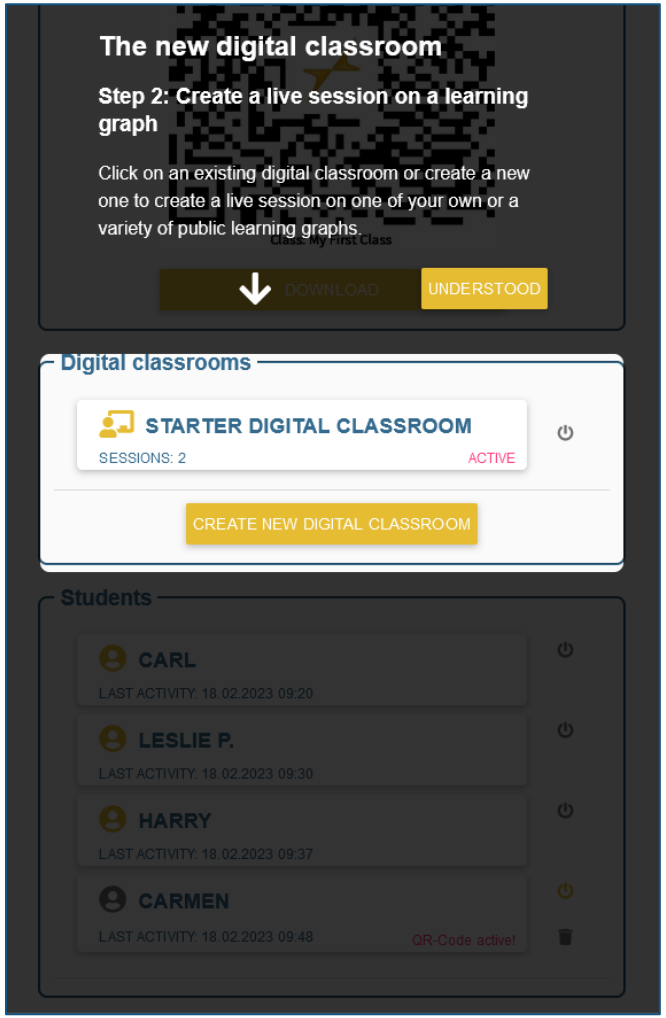


The Digital Classroom

Allocation of learning graphs to students:

- Click on „Starter Digital Classroom“

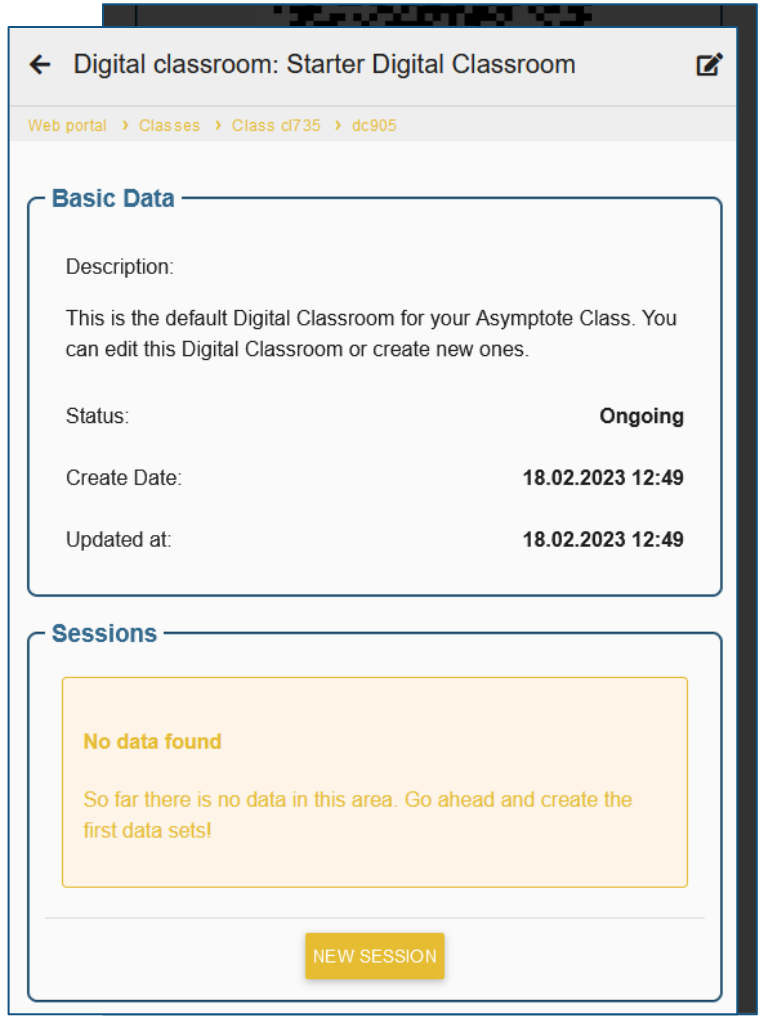
- One could also create further Digital Classrooms to conduct lessons based on …
  - topics (e.g., “All about functions”),
  - terms (e.g., “2nd term of 2023”), or
  - methods (e.g., “Exam preparation”)



The Digital Classroom

Allocation of learning graphs to students:

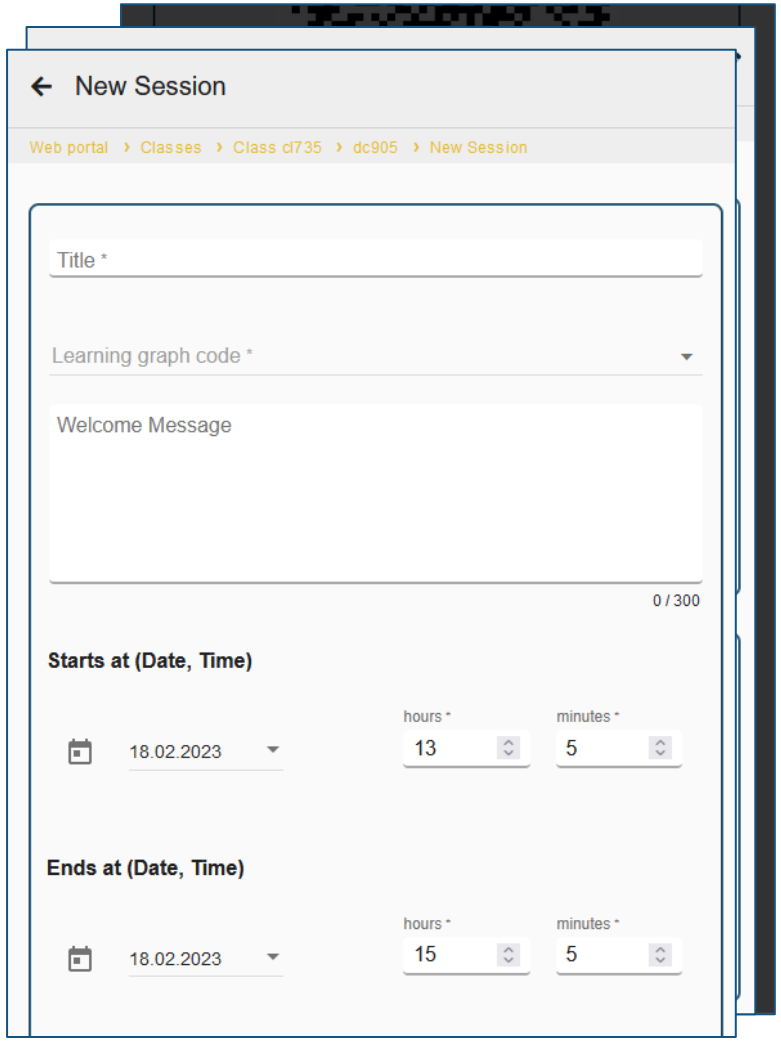
- Click on „Starter Digital Classroom“
- Click on „New Session“



The Digital Classroom

Allocation of learning graphs to students:

- Click on „Starter Digital Classroom“
- Click on „New Session“
  - Enter a title for the new session
  - Select a learning graph of your choice
  - Add a short welcome message for students
  - Determine the time in which the LG is accessible



The Digital Classroom

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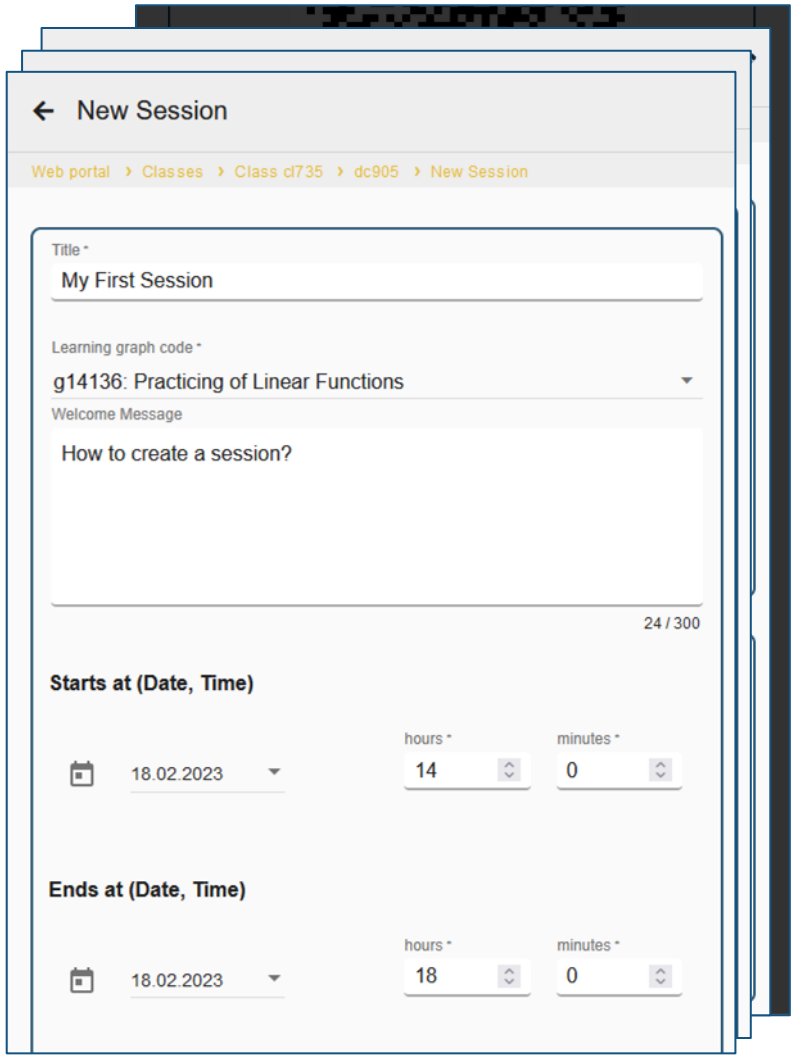
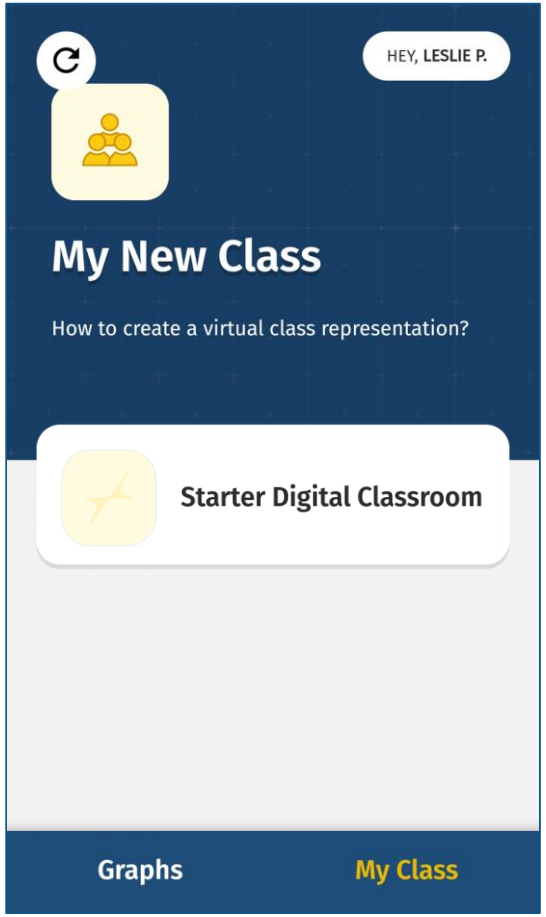


What is a session?
A session is the time period in which a specific LG can be completed by the students.
All task processes & chat interactions are stored in the session for evaluation purposes.
Within one Digital Classroom, multiple sessions can be created.

The Digital Classroom

Allocation of learning graphs to students:
The student‘s perspective (app)

- After entering the class via the QR code, the class is displayed under "My Class".
  - No registration is needed on student’s side!
- All Digital Classrooms of this class are displayed here



The Digital Classroom

Allocation of learning graphs to students:

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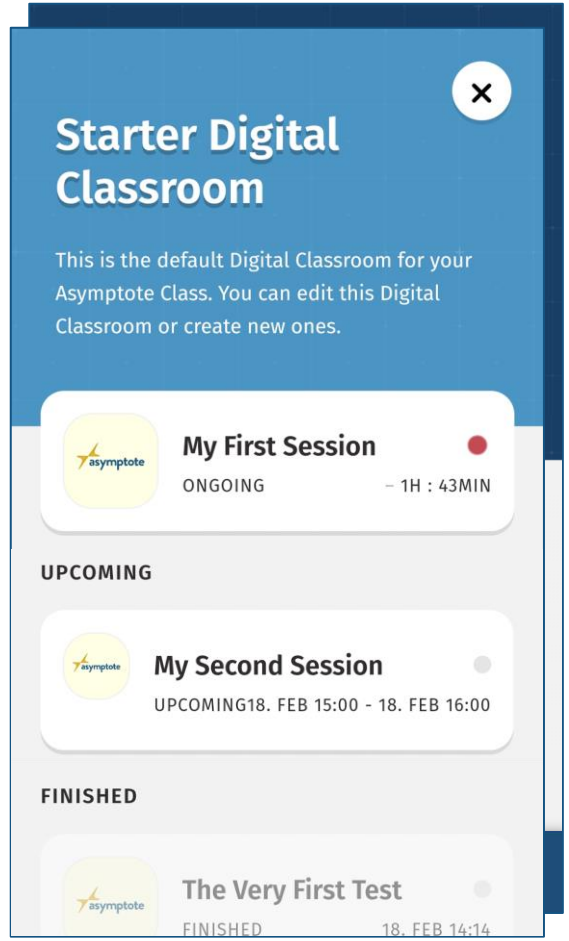
- All Digital Classrooms of this class are displayed here
- In a Digital Classroom, all sessions are shown
  - Currently available LG are marked by a red dot
  - „Upcoming“ shows already planned sessions
  - „Finished“ shows passed sessions



The Digital Classroom

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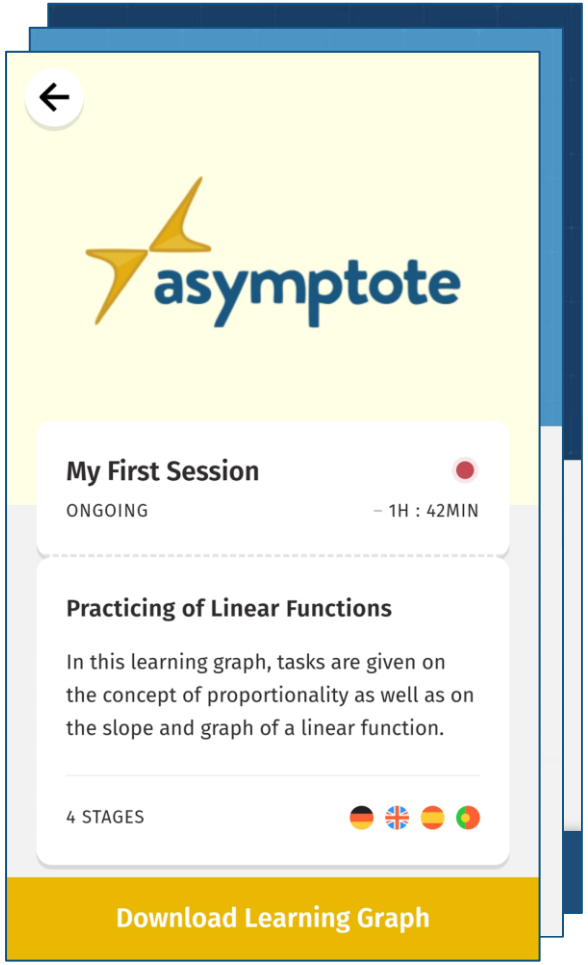
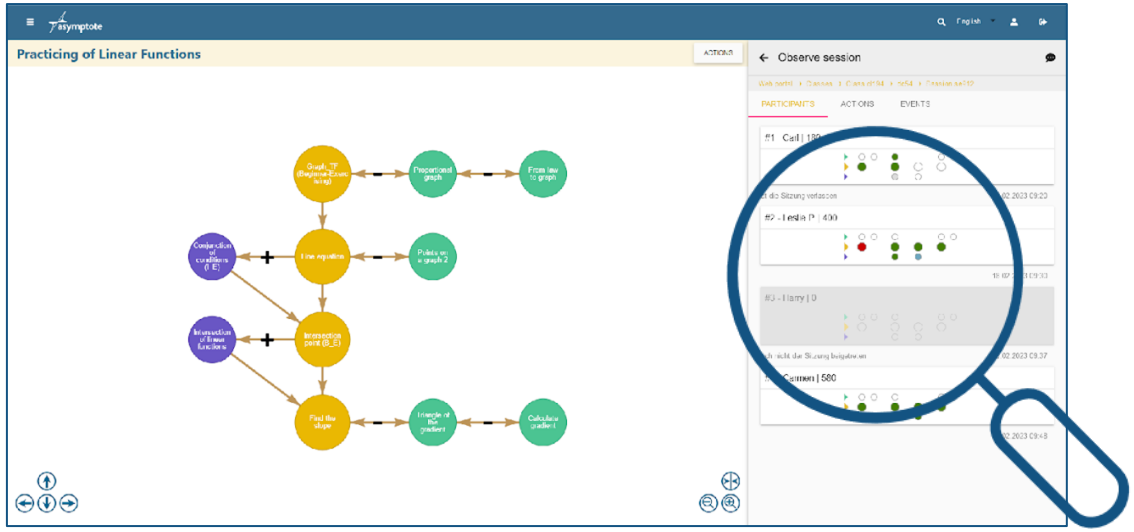
- All Digital Classrooms of this class are displayed here
- In a Digital Classroom, all sessions are shown
  - Currently available LG are marked by a red dot
  - „Upcoming“ shows already planned sessions
  - „Finished“ shows passed sessions
- By clicking on a current session, the related LG can be accessed



The Digital Classroom

Real-time monitoring of student‘s work process:

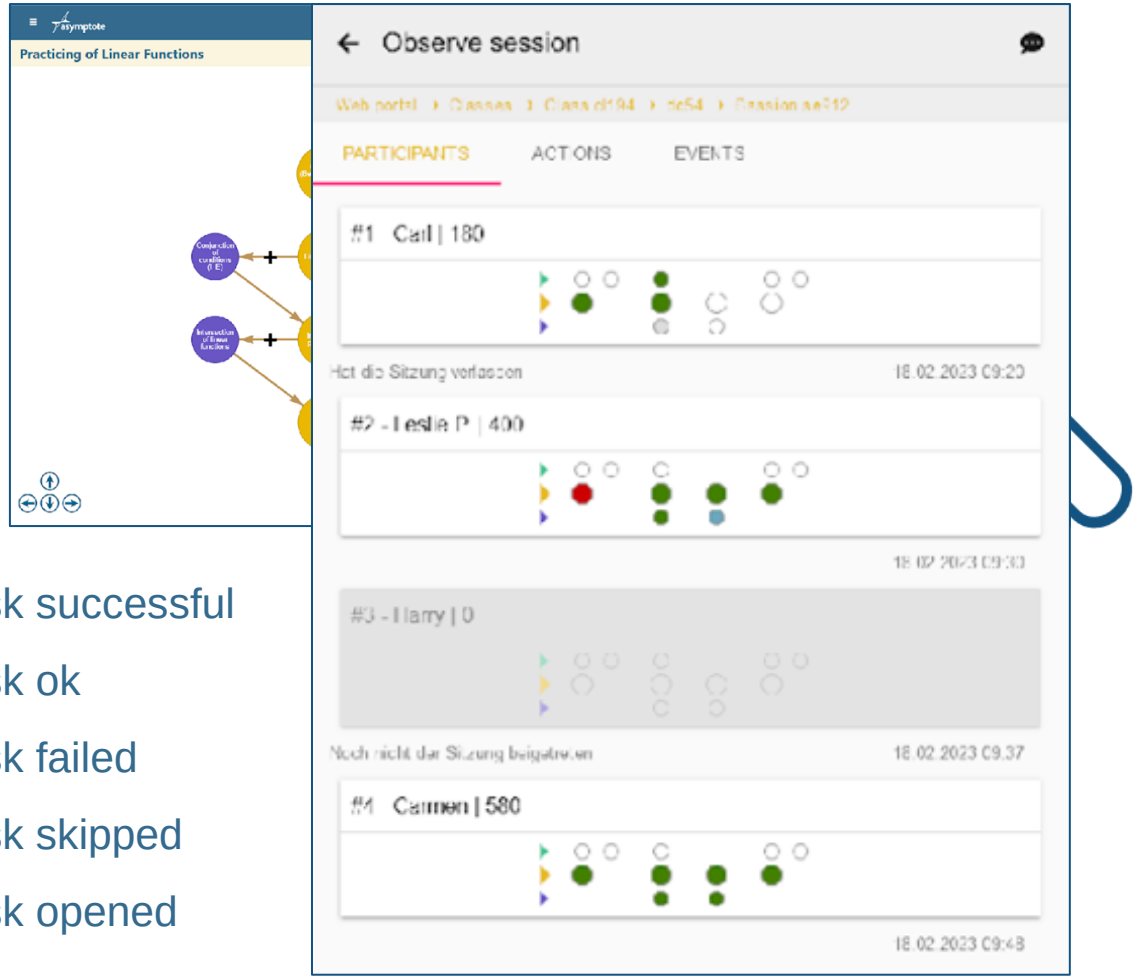
- Synchronously view of the work process:
  - How are the students doing progress?
  - Do they need support?



The Digital Classroom

Real-time monitoring of student‘s work process:

- Synchronously view of the work process:
  - How are the students doing progress?
  - Do they need support?
- Monitoring on class level
  - Received points are displayed
  - LG & work process is represented

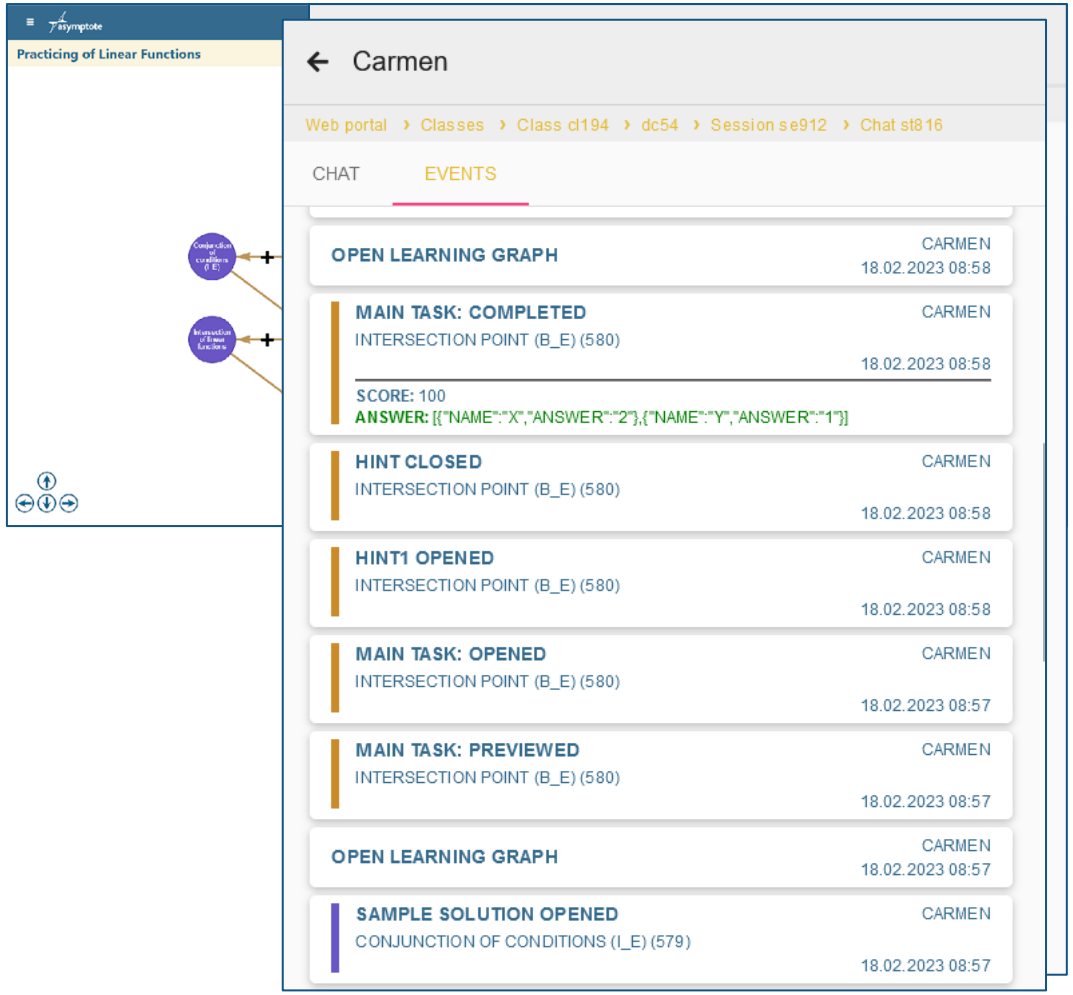


- Task successful
- Task ok
- Task failed
- Task skipped
- Task opened

The Digital Classroom

Real-time monitoring of student‘s work process:

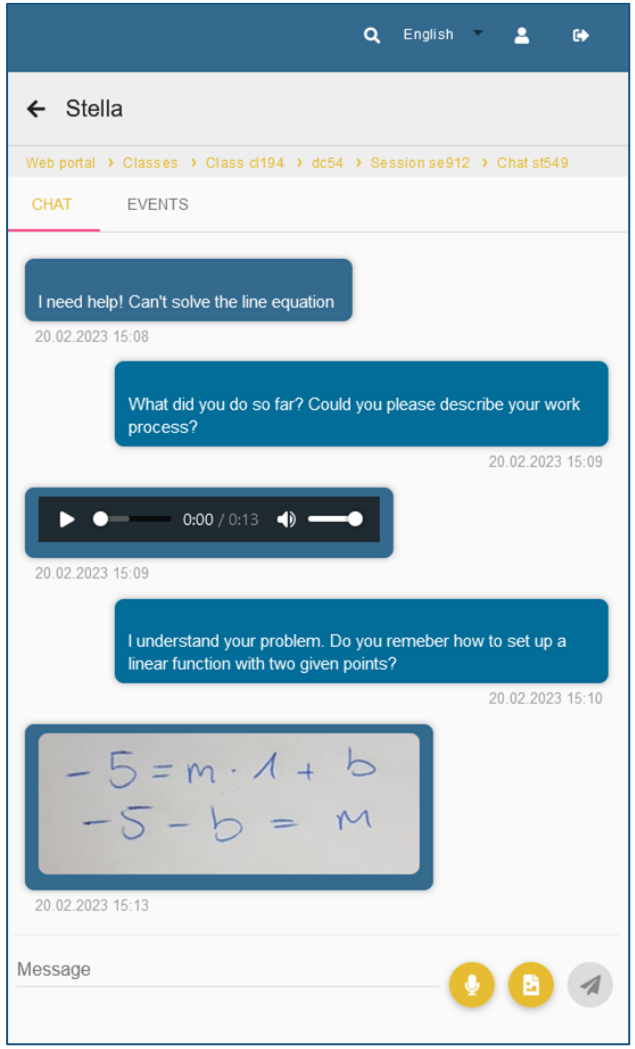
- Synchronously view of the work process:
  - How are the students doing progress?
  - Do they need support?
- Monitoring on individual level
  - Student‘s interaction with app is stored under „events“
  - Get a detailed insight in student‘s work process



The Digital Classroom

Student-teacher interaction via chat:

- Synchronous communication via chat
  - Text messages
  - Images
  - Audio messages



Support your students & give individual feedback despite of the online setting!

The Digital Classroom

Evaluation on individual & class level:

- Use the monitoring function for an evaluation of the work session:
  - Which students performed very well?
  - Which students need further support?
  - Which task was perceived as difficult?

Note: By comparing student‘s performance on various LG within one Digital Classroom, you can perform a basic long-term analysis!

Data Protection within the Digital Classroom

Information on data privacy:

- The data is processed and stored in Germany (1&1 - Frankfurt site).
- The collected data is not personal
  - No registration for students necessary
  - No email addresses required
  - No clear name required: users choose a pseudonym
  - Identification is done temporarily via random key
  - Encrypted transmission of data (SSL)

ASYMPTOTE complies with the provisions of the GDPR

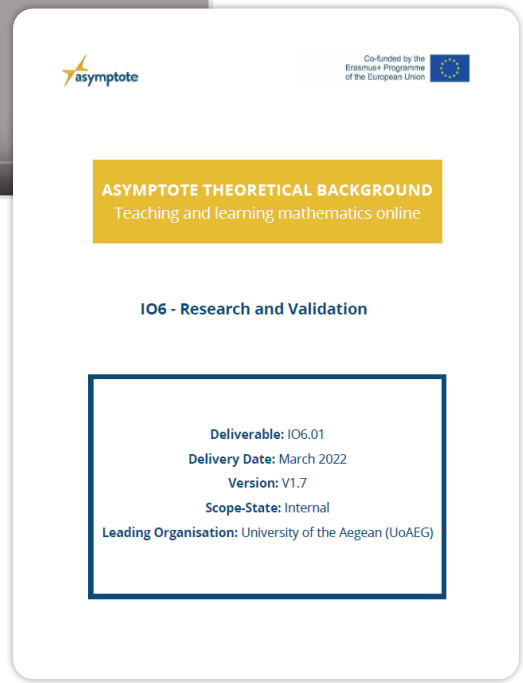
Supporting Material

8. Video Tutorials & Manual

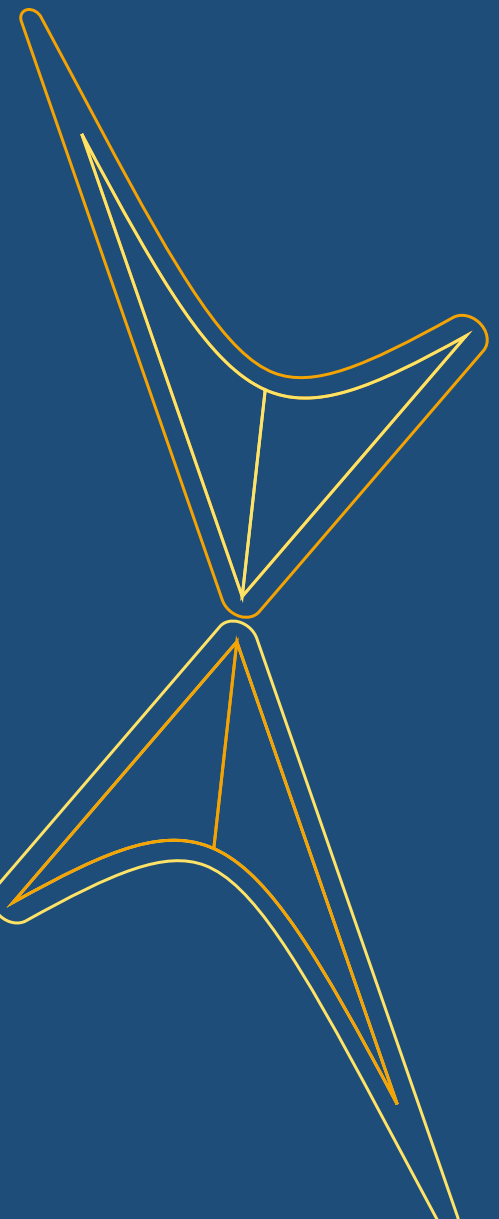
ASYMTPOTE Video Tutorials and Theoretical Background

Below this link you find …

- the ASYMPTOTE manual
- a playlist of video tutorials in English (subtitles in English, German, Greek, Italian, Portuguese and Spanish)



Further, you have access to the ASYMPTOTE Theoretical Background.



asymptote

Have fun to explore the world of ASYMPTOTE!