Curiosity, an update of a basic didactical approach

Image 7 on page 12 , is a representation of the way in which education (in this case technology, specifically digital technology) can be designed and initiated for students, in order to optimally stimulate and initiate their learning processes, so that it leads to success experiences, excitement, enthusiasm for learning. It is by no means a conditional format, an obligation, a formal route for designing meaningful education, but it can help a teacher to reflect on what may be important as a starting point for meaningful education for students so that they can achieve full educational, vocational and social maturity. As the title implies, it is not a new educational theory that has led to the 'curiosity model', but merely the combination of existing pedagogical and didactic insights into a meaningful whole

WHAT IS SO "21ST CENTURY" ABOUT 21ST CENTURY SKILLS?[1]

'Rotherham and Willingham state that there's nothing new about 21st century skills'. A statement presented in Kirschner's blog (Kirschner, 2022)
All of the below stated skills, are crucial to obtain and to maintain in ones (professional) lifetime. There is not much 21th century about these skills. Various theories about didactics are cited. None of these are new, but remain essential as a starting point for designing education, which gives children, young people, learners in general the right boost to work on their knowledge and skills development. Not to forget, the meta-cognitive skills that are crucial, to acquire optimal identity, professionalism and citizenship.

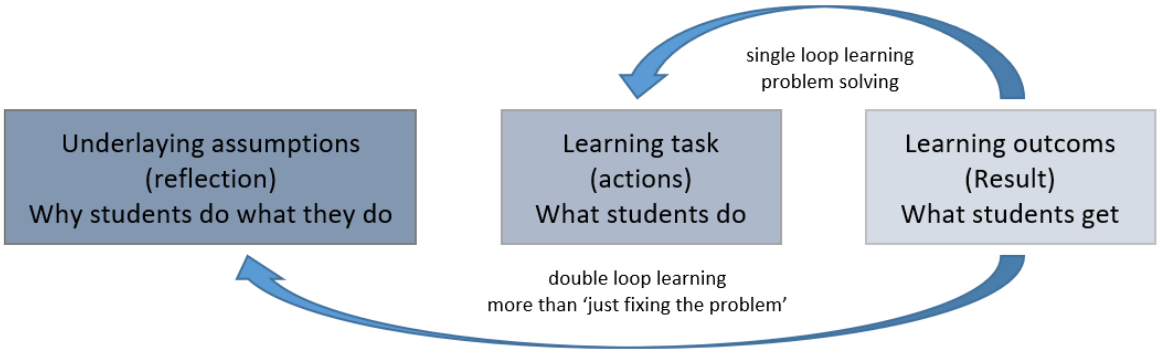
The twelve 21st Century skills are:

1. Critical thinking
2. Creativity
3. Collaboration
4. Communication
5. Information literacy
6. Media literacy
7. Technology literacy
8. Flexibility
9. Leadership
10. Initiative
11. Productivity
12. Social skills

DOUBLE LOOP LEARNING

To encounter young learners with their learning achievement, one could use the double learning system (Argyris, 2002). The double loop learning approach wil encounter students in a reflective way on their learning process. Students take a step further in problem solving process, students go a step further in the learning process, they look for the underlying reasons of problem-solving thinking and working within their assesigments. This also appeals to the psychologically powerful Aha experience (Aha-erlebnis: Karl Bühler wich is simular to eureka of Archimedes), as stated in 'Investigating the Moment when Solutions emerge in Problem Solving' (Losche, 2018). 'The Aha experience and the Eureka experience emphasise the psychological aspects of the moment when ideas come into existence.' New permanent insight has arisen. Duncker (1935/1963) uses the term Aha for the moment of sudden realisation and adds a new dimension to it by explicitly linking it to the reorganisation of thoughts… (Losche, 2018)

[1] https://3starlearningexperiences.wordpress.com/2016/11/01/21st-century-skills-dont-exist-so-why-do-we-need-them/



CAR Competence Autonomy Relation

With the well-known CAR model of Deci and Ryan (2000) Competence, Autonomy and Relationship, a teacher can create an environment for students in which they are motivated to shape their learning independently, in which they have freedom of choice in how and even what to learn, they are stimulated to look for connection with something or someone. And students can learn things, and determine what, and to what extent they master certain knowledge and skills . Ros, A., Castelijns, J., Van Loon, A., Verbeeck, K. (2014) have translated these CAR conditions into daily educational practice. See table below

Deci & Ryan (2000)	Ros. A, et al (2020)
Autonomy Self-direction and choice	- Do not put pressure on students - Explain to students what it means for his/her personal interest - Offer freedom of choice - Let students experiment and give space to their own ideas by asking open questions - Show interest in and empathy with the students when motivation is low. Indicate why the assignment must be done anyway. - Connect the subject matter to the student's experience
Competence Develop skills and experience progress	Providing structure gives the student something to hold on to. This can be done by: - Formulate learning objectives - Express expectations - Clear communication - Be consequent - Let the student learn self-directed but be on standby - Create partial assignments or work on an assignment in steps - Emphasize positive behavior - Provide assignments that are challenging and appropriate for the level - Meaningful teaching
Relation - Connectedness The need to belong / to feel connected	Focus on a good relationship with students - Manage, help and understand - Feel and understand social situations - Don't judge - Each student is unique - The teacher knows the student's motivation - Knows his target audience - stimulate connection with knowledge content

CHILDREN FULL OF LIFE

'The interests the children show and the questions they ask should be valued and not rejected by stubborn adults' (Toshiro Kanamori)

Listen to your children, encourage learning everyday things. What kind of adults will our children become? Do they become the builders of a peaceful state and free society? Will they become adults with a broad outlook on life who think carefully, do not put pressure themselves or others and make an effort to make both themselves and others happy and that they always keep a learn attitude and to think creatively.

EXEMPLARY EDUCATION

Those who stand in front of the class know better then to let policy makers have their say in the classroom...(Weigand-Timmer, 2007) in Voorbeeldig Onderwijs (van Tongeren, Pasman-de Roo (red.), 2007). With common sense and feeling they substantiate actions in a classroom. Teachers should generate this substantiation from these questions, which all teachers should frequently ask themselves;

Why do we (they) need to learn? What should we (they) learn? How should we (they) learn? How should we evaluate education? How should we organize education?

Exemplary education includes parents who dare to transfer the education of their child to the school. A child needs a community of exemplary people, whom children can emulate and lean on. These are primarily the parents themselves. However, schools take into account the parental community from which their students come, they pay attention to diversity and inclusiveness and therefore pay attention to the community in which students later have to function.

Parents and schools who, from the perspective of 'doing justice to all dimensions of being human', constructively work together to tackle the complex task of educating and raising children.

THE ART AND SCIENCE OF TEACHING

Learning goals

> 'When considering the instructional question; what will a teacher do to establish and communicate learning goals, track students progress and celebrate success? Teachers should think about three basic elements;
>
> First. Establishing and communicating learning goals involves distinguishing between learning goals and learning activities and then writing learning goals in a suitable format. Second. Tracking student progress on individual learning goals involves using formative assessments and a scale designed specifically for formative assessments. It also involves charting students progress on individual learning goals. Third. Celebrating success involves recognizing and acknowledging students knowledge gains.' (Marzano, 2007)

Student engagement

Marzano states that there are 5 areas that can provide useful insights into how teachers might increase student engagement (Marzano, 2007). High Energy, Missing Information, The Self System, Mild Pressure, Mild Controversy and Competition

High energy:

- Boost energy by physical activity (blood flow, increased oxygen transport to brain)
- Pacing of instruction; keep the activity moving and avoid interruptions, avoid slow transitions between activities
- Teacher enthusiasm and intensity (animated behavior arouses the attending behavior of pupils)

Missing Information:

- Tap into the sense of curiosity and anticipation. 'curiosity and anticipation are known as appetitive states because they stimulate the mental appetite'. (Jensen, 2005)

The Self System

- The self system is made up of two major aspects/structures: The 'me' self and the 'I' self (McCaslin et al 2006)

Self System structures consist of the 'I' self and the 'me' self. The 'I' self is the source of more enduring natural and higher order self concept; the 'me' self is more task or domain specific. The 'me' self is a sort of working self concept that is the source of motivation and self regulatory strategies in a particular context. The 'me' self can get in the way of the 'I' self.

The ‘me’ self is more specific to situations, and can lower motivation. If a student has a low self perspective of his mathematics comprehension, he might be less engaged in mathematics class. The ‘I’ self is the composite of everything we find personally interesting and valuable. Topics that include aspects of the ‘I’ self will therefore attract more attention form a learner. (McCombs, 2001)

- Mild Pressure

Under the right circumstances mild pressure can have a positive influence on learning. (Jensen, 2005) It is important to apply pressure at the right level of intensity and for the right duration of time while instructing.

- Mild Controversy and Competition

Jensen refers to behavior, known as ‘engineered controversy’ (Jensen, 2005) as for example in a structured debate. It can enhance learning (when controversy is not to strong). Bringing together students with different opinions and allowing them to engage in a controlled dialogue about these different opinions has a positive instructive effect, according to Good and Brophy (2003). To stimulate an engagement activity, one can also apply mild competition, (winning prizes, or merely for the satisfaction of winning) ‘to add excitement’ to classroom activities.

VISIBLE LEARNING FOR TEACHERS

Getting kids to engage in learning activities in a formal educational setting is not something that happens naturally.

If all educational psychology were reduced to one rule, this would be; the most important thing for learning is the student's already acquired knowledge. Search for this knowledge and connect with it. So claims David Ausubel (Ausubel, as shown in ‘Leren zichtbaar maken,’ Hattie, 2014). Shayer (Shayer, 2003, in ‘Leren zichtbaar maken,’ Hattie, 2014) states that If you want to generate viable engagement from all students, it is important to clearly visualize the mental levels of students and the cognitive demands of your lesson. Only then will a teacher be able to prepare and implement an effective didactic method.

Teachers must ensure that a challenge is adapted to the special needs of the student at a given time. That is one of the most important tasks of a teacher. Students learn only if the work they are doing is moderately challenging and if there is enough help for the student to master what initially seems out of reach. (Tomlinson, 2005, in ‘Leren zichtbaar maken,’ Hattie, 2014).

Maximizing learning is best done by using the ‘backward design model.’ (Wiggins & McTighe, in ‘Leren zichtbaar maken, Hattie, 2014). Knowledge about what the success of a lesson looks like, before we start setting it up is the essence of reasoning back. This knowledge also allows a teacher to improvise and make changes while teaching, without changing the concept of success. The focus for setting up a lesson here lies more on the use of learning strategies to achieve the lesson goal than a specific lesson approach. Through a well-thought-out learning strategy, a teacher can intervene where and when necessary during the lesson. The ability to change and innovate continuously in the process is the essence of adaptive expertise', primarily for teachers, and more and more for students as they develop their self-regulation.

GAMIFICATION

Lessons that benefit most from using games are those that don't go as well. Within traditional education, teachers and their instruction are focused on explicit knowledge transfer. In this formal setting, students must absorb facts and concepts and reproduce them at a later time, in the hope that they have also assimilated this knowledge. This approach has some success, within certain subjects, and is not always fun for students. That shouldn't be a problem. They will also be confronted with less pleasant things in later (professional) life. Students also have to deal with this aspect of life. The need to adapt education comes when the explicit transfer of knowledge falls short. When you want to convey an experience, when you want to surface a conviction or when you want to practice a skill. In all of the above situations, traditional education is not sufficient, and it is worth considering using a game. (Koops, 2017)

Traditional lessons are mainly aimed at declarative knowledge and appeal to reason. This approach fits well with the exams for which we prepare students. Knowledge games can also have a function within the application of declarative knowledge, these are the knowledge games. The added value of an educational game lies in focusing on skills, understanding, attitude. Educational games can help a teacher adopt a student-centered approach within these domains. (Koops, 2017)

Teachers often forget the role of intuition in making decisions. When we need to make a decision, our intuition will help us with a suggestion based on a previous experience. An intuitive hunch is often right, but can also fall

short, and then we better make a rational decision. Kahneman (2011) (Kahneman, in Game didactics, Koops, 2017). We must help students learn to distinguish when to rely on intuition and when on reason. We need to train their brains on this. Only then do knowledge and the application of knowledge come together in making optimal decisions.
Games are particularly suitable for evoking intuitive reactions, because they take place in a fantasy world. They have no real life consequences. The player does not have to be wary, and can rely on his intuition. Because intuition becomes visible it gives us the opportunity to explore and shape it. (Koops, 2017)

EFFECTIVE LEARNING

The focus is within the comprehensive concept of 'effective learning' in this discussion on motivation and metacognitive skills. Attention to curiosity and motivation, according to the 6 key concepts of Ebbens and Ettekoven (Ebbens & Ettekoven, 2015) lies in giving meaning to the subject matter. Students must be able to give meaning to the subject matter *for themselves*. They must know and understand why certain subject matter is offered at a certain moment and why they should learn this subject matter.
Intrinsic motivation is the input for students' curiosity, ambition and perseverance. This is the so-called 'own drive'. A teacher is able to generate curiosity when he is able to find the intrinsic motivation in students
Affective skills, or reflective skills, help students to generate self-knowledge. Self-knowledge that they acquire when they attribute learning outcomes to themselves, i.e. to their personal effort, perseverance, concentration, discipline and persistence, when performing a task, or purely by chance. Metacognitive skills go one step further. They give students insight into their skills such as orienting, analyzing, planning, choosing an approach, monitoring their learning process, testing themselves, adjusting, evaluating and finally reflecting (affective skill).

CURIOSITY

'Between boredom and alienation', as Roland van der Vorst states in his book 'Curiosity, how we are seduced every day' is the balance we must generate to keep the power of curiosity alive. Curiosity offers the prospect of a new world. That can be a world that is 'withheld', a world that is different from what you are used to (your world is disrupted). A world that is 'open' in which you can experiment or a world that is specifically referred to. (ask for something). These four principles; withholding, disturbing, keeping open and asking can reinforce each other, if your curiosity is successfully stimulated, some of these four principles can be used side by side.
If you are made curious, you will be misled or deliberately left in the dark. The principles of withholding, disrupting, keeping things open or asking about them confront you with aspects around you that are unknown, new, ambiguous, complex, mysterious or as yet incomprehensible (Van der Vorst, 2007)

If things surprise you, this apparently leads to curiosity. If you are not surprised, boredom sets in and you don't feel like exploring further, looking for something. The aspect of surprise cannot be stretched indefinitely (see image 3). Too much surprise can lead to dropping out. The trick is to keep a sufficient distance. As a teacher you ensure that your students stay at a safe distance, so that they do not become alienated from the subject, the assignment, the project. Your curiosity is optimally stimulated, and maintained if the information you receive is somewhere between alienation (unreachable, new, unbelievable, uncertain, incomprehensible) and boredom (reachable, the same, known, credible, certainly understandable). When you add the word ‘too’ on these concepts, it will put you as a teacher in the position of understanding what the student might experience.

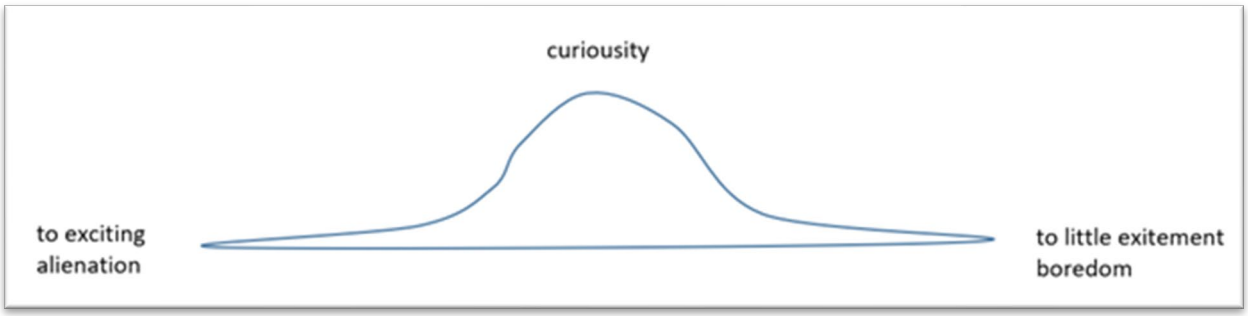


Image 3 (Van der Vorst, 2007)

For example; the principle 'withhold'. (see image 4). If we withhold too much information, what we are looking for becomes unreachable. On the other hand, if we give away too much information, something becomes 'just accessible' and we can get bored. We see this effect with the intensive use of social media. With all the abundance of information we get from and about famous pop stars, actresses and football professionals, we can also get bored. A documentary often gives us so much insight into a subject or person that leads to a degree of knowledge about the subject or person in question that our curiosity could be quenched just like that.

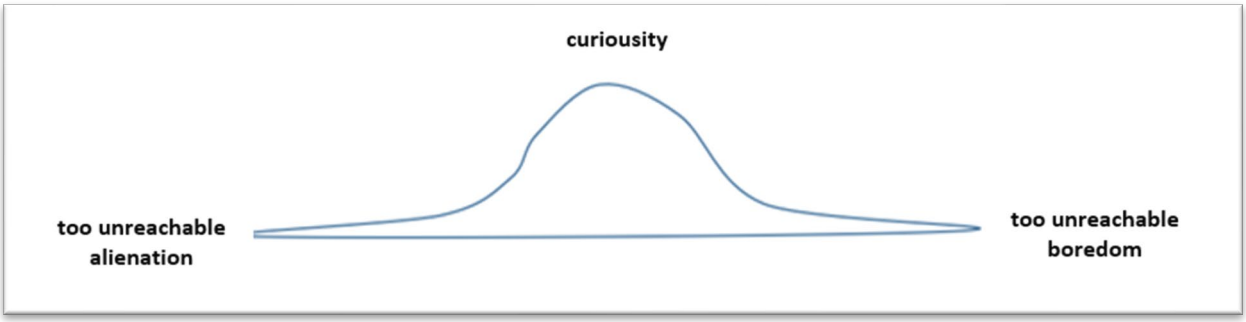
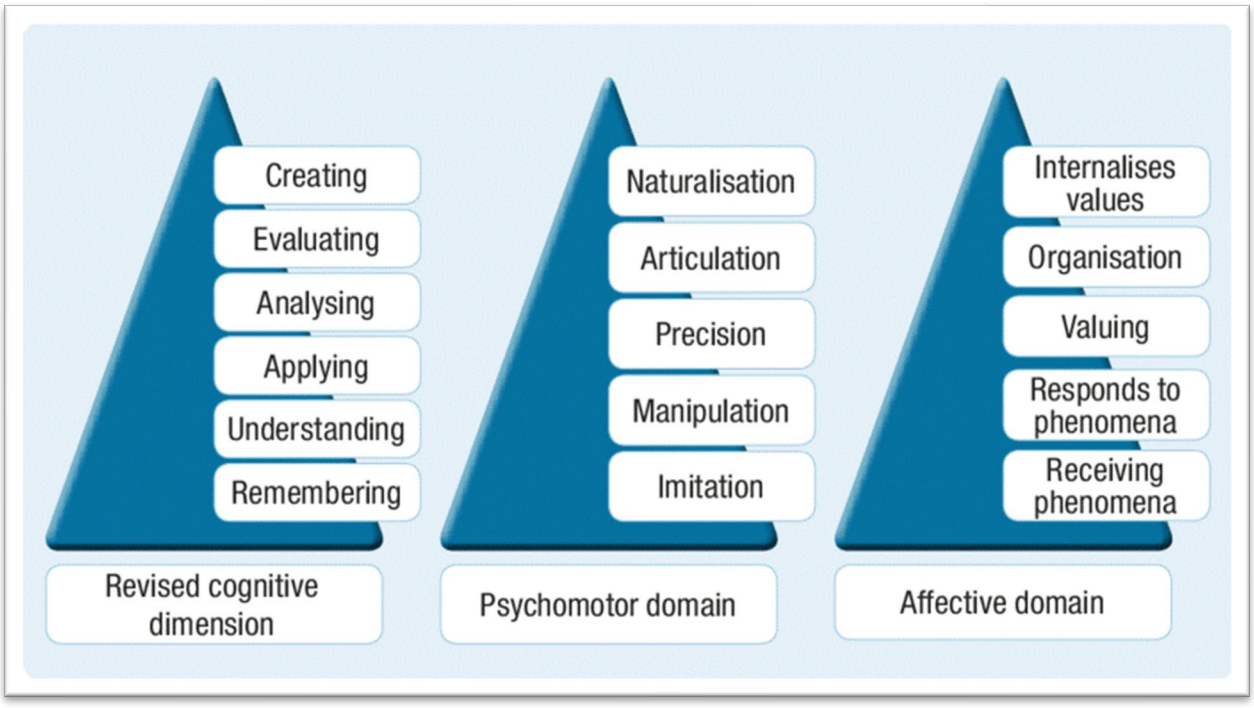


Image 4 (Van der Vorst, 2007)

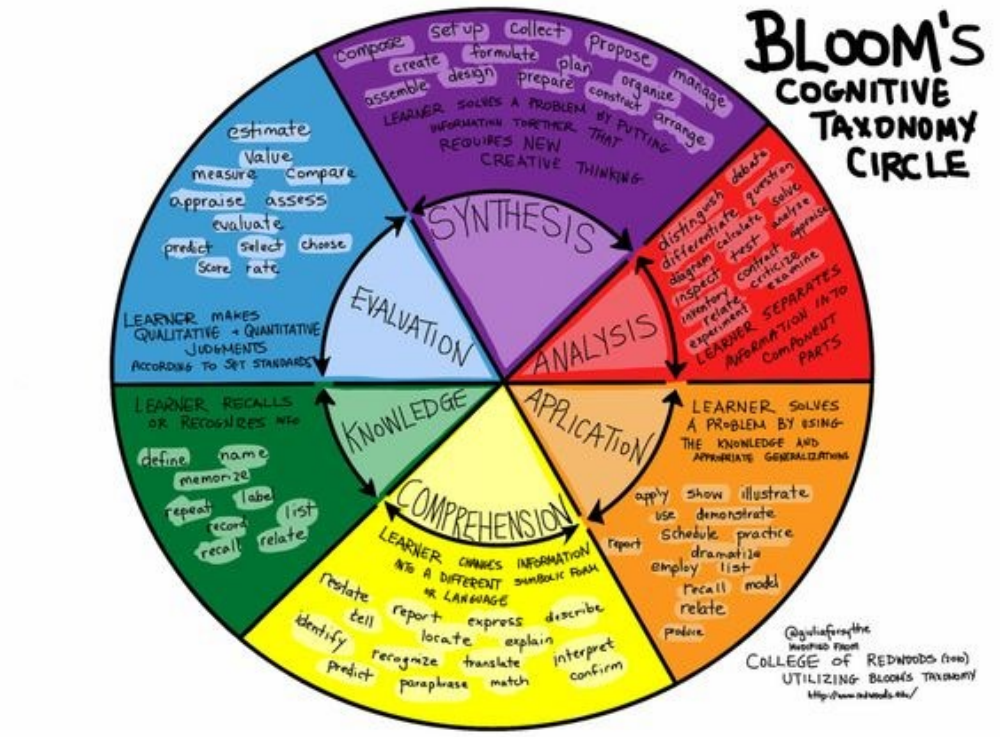
TAXONOMIES

The taxonomies shown in the pyramid shape in image 5, gives the impression that there is a clear hierarchy. In confronting students with learning activities, a learner does not always have to remember facts and concepts before he or she creates a technical (digital) product.

It is therefore desirable to use the circular form of a taxonomy, since we can have a student start a learning activity from each of the aspects shown in de pie chart (image 6, modified from the College of the Redwoods, 2010). In this circular revised Blooms taxonomy, we also see that 'create' has been replaced by synthesis which includes the aspect of creating, and thus offers a broader perspective, on generating learning activities. Automating (naturalisation) of a psychomotor skill does not always have to be the ultimate goal during learning activities, imitation can generate enough knowledge, necessary to successfully complete a project.



Bloom, 1956 - Anderson, Krathwohl, 2001 *Dave, 1974* *Krathwohl, Bloom, Masia, 1964*

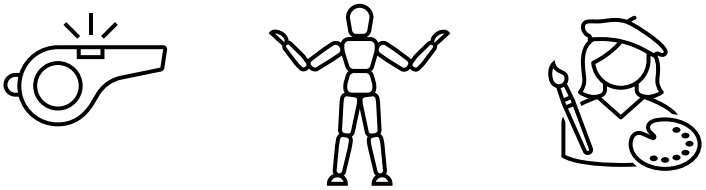


SELF-REGULATED LEARNING – LEARNING STRATEGIES

Students need learning strategies to become independent and self-regulated. Not just for learning, but also for life. Scientific research has shown that there are fourteen learning strategies that students can use to optimize their learning process (Dijkstra, Bunnik, & Krikke, 2022). The fourteen learning strategies are clustered in 5 groups.

1. metacognitive knowledge; overseeing and knowing yourself
2. metacognitive skills; to look ahead, keep track and to look back
3. cognitive skills; repeat, deepen, structure
4. organizational skills; organize yourself, organize your environment, organize others
5. motivational skills; trust yourself, see the benefit, motivate yourself

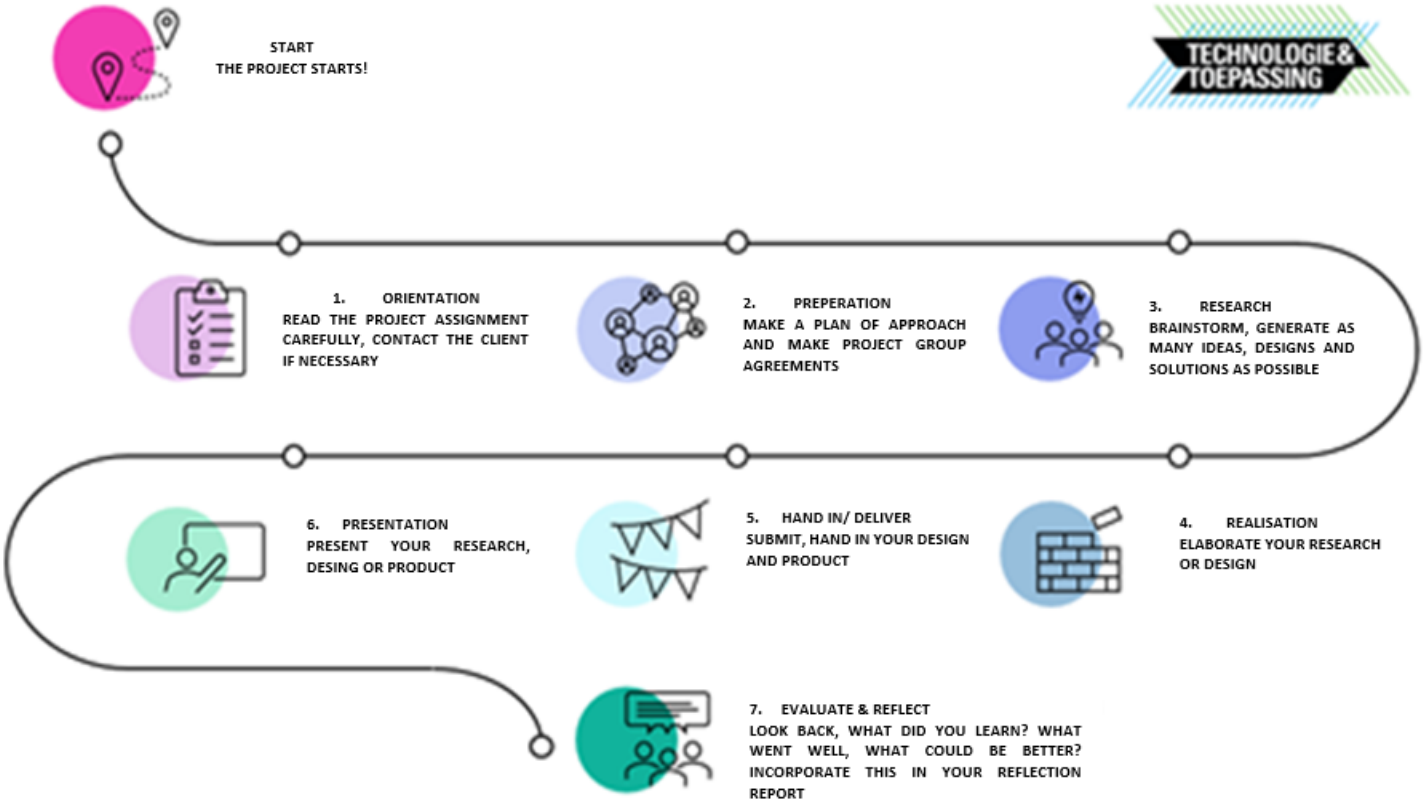
When it comes to student learning strategies, the teacher fulfills at least three roles. the role of coach, role model and creator



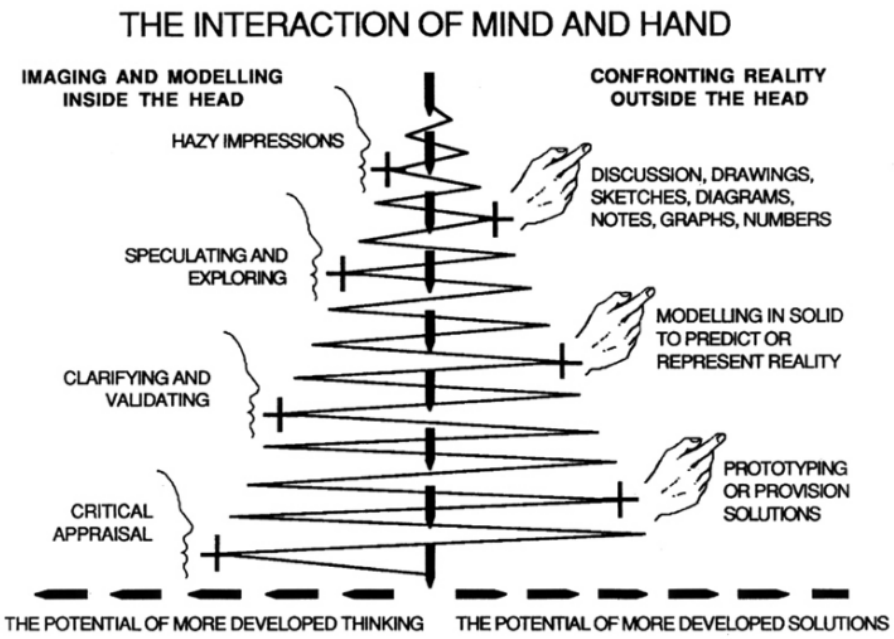
PROJECT BASED LEARNING

The advantage of project based education is that it is based on an appealing relevant context and focuses on the creativity of students, and includes options for differentiation. Is can be cross-curricular in an organic way. In Project based education students learn from product development and the project process and students engage in social competences (Winkels & Hoogeveen, 2018). With the vocational and or social contexts of the educational projects you form a beautiful colorful palette of the pluriform, multicultural world around us.

in image 7 a is shown in how project bases learning is designed within de (new) Technology & Apply educational program (Technologie & Toepassing, 2022) in Secondary Education in The Netherlands (age 14-16)



DESIGN DIDACTICS THINKING AND MODELLING

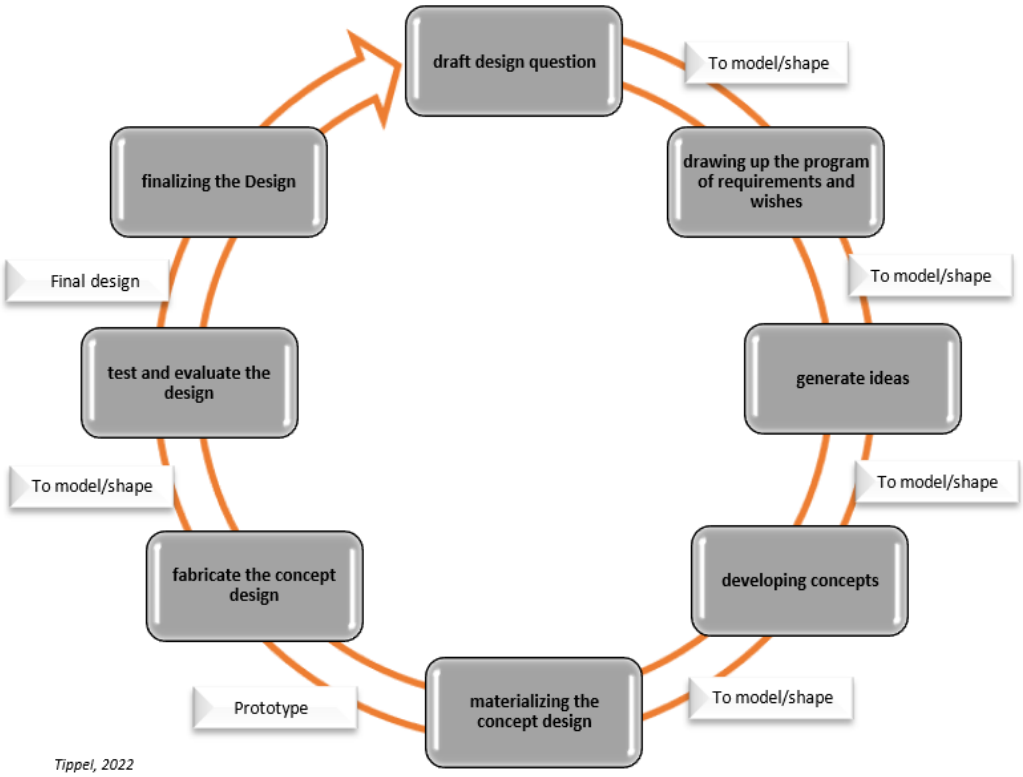


In the above design and technology model by Kimbell (Kimbell & Stables, 2008) there is a continuous interaction between doing (hands on) and thinking (minds on). Students with a practical and/or contemplative preference keep going up and down between doing and thinking. The visibility of learning and thinking is optimal in this methodology. Doing and thinking are closely related, both in time and in function in the entire design process. With this didactics you will convert trial and error into 'Observe and Explain'. Did it work? How did it work. How does it look? Are you happy with it? Was it planned? What was your plan? Why did it work? Why didn't it work? How could it be otherwise? What would you do next time? Do it, try it! With these questions you can move students back and forth between thinking and doing. Curiosity and direct feedback reinforce each other to learn double loop. This methodology works both for making physical 3D models and also within the digital world such as manipulating software. In software, inputs, processing, cunning (sub)routines and outputs form the manipulable variables (materials) with which to arrive at a working system.

DIFFERENTIATION

Observe, explain and adjust (again). You could also consider all this as a guided processing, so that differentiation can be used optimally (Berben & Teeseling, 2018). The next step is to add 'Predict'. The student will then use predictions to make something. This leads to; 'Predict' 'Observe and Explain'. As a teacher you guide this process. That something works is nice, but what was your prediction, and does it match reality with what you modeled? The entire process of Predict, Observe & Explain is focused on learning and transfer. An additional advantage is that students are actively involved in this approach. According to Teitlers ‘Keep them busy’ (Teitler, 2017) which is an important pedagogical means of maintaining learning and transfer. On top of that, as a teacher you have to differentiate. After all, not every student is equally advanced, equally handy, equally smart. Differentiating in instruction, learning time, processing and attention are logical tools in the learning process. As a teacher you pretend to be or let yourself be, according to; 'show-imitate-practice together' (Winkels & Hoogeveen, 2018) a perfect approach for learning and using machines, tools, hardware and software. ICT is used here in a natural way in designing (drawing software) and making (3D printing and laser cutting). And pretending and imitating regular instructions is done, for example, with the help of the hololens. The student thus experiences a perfect application of a new technology.

DESIGN PROCESS & MODELLING



Achieving a solution for a problem of a technological nature in the form of a product, by carrying out a design process or design method, with attention to the social context in which this product must fulfill its function. The design process arises where there is a need for a new or improved product. (Tippel, 2020).
A designer is out to convert design thinking into modeling within each phase. This is a translation from Kimbell's model ; 'The interaction of mind and hand' (Kimbell & Stables, 2008) and is as opposed to back and forth model of Kimbell and Stables, a circular model. However, this didactic model is representative of a process that repeats itself, is iterative, in which a novice designer (i.e. a student) after each phase generates a visual model to optimize the externalization, (Tippel, 2022) in order to 'achieve a better potential in developing better solutions' (Kimbell & Stables, 2008)

SUMMARY AND CONCLUSION

The above educational theories in the technological, didactic and pedagogical field have been input for the model in image 7. The model is not a rigid, fixed format or precondition for good education. It is a means, a vehicle, a tool, a starting point, from which learning processes and learning activities can be initiated.

Whether as a teacher you have a mechanical object, a wooden artifact designed and made or if you are giving a student a maintenance task for a device or asking students to develop a digital product, the model and diagram below is a path through which your learning activities can proceed from curiosity, specifically the four principles; *withholding, disturbing, keeping open and asking*, can be a starting point, triggering and maintaining curiosity.

Bibliografie

Argyris, C. (2002). Double-loop learning, teaching, and research . *Academy of Management Learning & Education, 1(2)*, pp. 206-2018.

Berben, M., & van Teesling, M. (2018). *Differentieren is te leren.* Amersfoort: CPS.

Deci, E. L., & Ryan, R. M. (2000, januari). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, pp. 68-78.

Dijkstra, P., Bunnik, P., & Krikke, A. (2022). *Zelfregulerend leren, effectiever leren met leerstrategieen.* Amsterdam: Boom.

Hattie, J. (2014). *Leren zichtbaar maken (Visible Learning for Teachers).* Rotterdam: Bazalt.

Ingeborg Hansen. (2012). *Levenslessen van meester Kanamori.* Driebergen: Het Kind.

Kimbell, R., & Stables, K. (2008). *Kimbell, R. & Stables, K. (2008). Researching design learning. Londen: Springer.* Londen: Springer.

Kirschner, P. (2022, september 23). *https://onderzoekonderwijs.net/2015/10/22/21st-century-skills-are-so-20th-century/*. Retrieved from https://onderzoekonderwijs.net: https://onderzoekonderwijs.net/2015/10/22/21st-century-skills-are-so-20th-century/

Kirschner, P., & Meelen, M. (2022, september 23). *https://3starlearningexperiences.wordpress.com/2016/11/01/21st-century-skills-dont-exist-so-why-do-we-need-them/*. Retrieved from https://3starlearningexperiences.wordpress.com: https://3starlearningexperiences.wordpress.com/2016/11/01/21st-century-skills-dont-exist-so-why-do-we-need-them/

Koops, M. (2017). *Game Didactiek.* Den Haag: Didactica.

Losche, F. (2018). *Investigating the Moment when Solutions emerge in Problem Solving.* Plymouth: https://pearl.plymouth.ac.uk.

Marzano, R. J. (2007). *The Art and Science of Teaching.* Alexandria VA: ASCD.

Paul van Tongeren, Karin Pasman-de Roo (red.). (2007). *Voorbeeldig Onderwijs.* Venlo: Thijmgenootschap.

Ros, A., & Castelijns, J. (2020). *Gemotiveerd leren en lesgeven: De kracht van intrinsieke motivatie.* Bussum: Coutinho.

Tippel, S. (2014). *Hoe ga je dat Ontwerpen?* Den Haag: Hogeschool Inholland.

Vorst, R. v. (2007). *Nieuwsgierigheid hoe we elke dag worden verleid.* Amsterdam: Nieuw Amsterdam.

Winkels, J., & Hoogeveen, P. (2018). *het didactische werkvormenboek.* Assen: Koninklijke Van Gorcum BV.

Image 7