

## LEARNING DESIGN FOR SCIENCE EDUCATION IN THE 21<sup>st</sup> CENTURY

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*Abstract.* Contemporary technological and social developments demand transformation of educational practices. Teachers and schools are no longer fountains of knowledge that fill students with information. Rather, their primary role is to equip students with new literacies, competencies for productive use of information technology, and sufficient disciplinary-specific bases of conceptual knowledge. This requires changes toward student-centered practices. In such contexts, teachers are designers of learning; therefore lesson planning is replaced with a concept of ‘learning design.’ This paper introduces the RASE (Resources-Activity-Support-Evaluation) learning design model developed as a framework to assist teachers in designing learning modules. Central to RASE is the emphasis on the design of activities where students engage in using resources and in the production of artifacts that demonstrate learning. The paper also emphasizes the importance of ‘conceptual models’ as a special type of educational multimedia resource, and its role in assisting learning and application of concepts, as opposed to the ‘information transfer’ models. RASE is beginning to emerge as a powerful framework for transformation of teachers and their traditional practices to contemporary, relevant student-centered practices. The model is also an effective framework for productive uses of information technology in education.

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### *Introduction*

Consider the changes that have occurred in the world over the past two decades. The Internet, Windows, MP3 players, game consoles, mobile phones, handheld multimedia devices like the iPad, digital cameras, Android, Interactive TV, Google, Facebook, among others. These tools and technologies have become inextricable parts of our cultural and social milieu, as well as a critical psycho-emotional function of today's student.

However, we are just at the beginning of a technological revolution which will significantly transform virtually everyone's life on the planet. Some skeptics expressed doubt, thinking these developments will be only for the worse. One consequence is inevitable – what we learned, how we learn, what we do with what we have learned, how we work, how we live and who we are – are all changing with these developments.

Governments around the world are presented with an enormous challenge of how to reform education in line with these technological, social, economic, and political developments that life in the 21<sup>st</sup> century has brought to us. Indeed, the concepts of the citizen, worker, student, teacher, and information, knowledge, authority, freedom, and even governments are all transforming.

Some educators think that the science curriculum needs to be narrowed in order to allow sufficient time for teachers to infuse new literacies required for today and tomorrow, including emerging competencies such as learning skills, problem-solving, critical thinking, creativity and collaboration skills. We conceptualize “new literacies” as a blend of competencies that include visual, critical, media, digital, and information literacy. From the more traditional view of “literacy” from the language perspective, new literacies build not only on reading, writing, listening and speaking skills, but also include viewing and representing.

Contemporary learning, including learning in the sciences, is critically intertwined with these emerging literacies. For example, working with data, reading (viewing) and representing scientific ideas are contingent upon visual literacy and skills in using representational technologies. The main aim of this paper is to introduce a learning design model to support student-centered learning and the development of new literacies in science education. A critical aspect of the learning design model is to guide teachers to (a) transform their practices in a student-centered direction, and (b) integrate the effective use of educational technologies into their learning and teaching practices. We argue that both aspects are important for the development of new literacies. The RASE Learning Design model emphasizes four components of a learning unit: *Resources, Activity, Support and Evaluation*.

The second aim is to emphasize the importance of concept learning in science education. A frequent problem in science and engineering education is that students are not supported and exposed to appropriate experiential learning (activity) and adequate resources to enable the development of conceptual knowledge that is required for understanding and thinking in the sciences. Teachers often concentrate on the teaching of facts, exposing students to information they require to remember (as opposed to deep understanding) for reproduction in examinations and other assessment tasks. Science educators need to focus on supporting students to develop sufficient bases of conceptual knowledge required not only for thinking and solving problems, but also for sense-making, and designing, engineering and applying technologies.

The third aim of this paper is to emphasize that as the world is becoming increasingly technologically sophisticated, students need to learn more scientific concepts than ever before. Our view is contrary to the popular belief that calculators and computers offload the need for learning certain content, thus reducing the total amount of content required by a given science curriculum. In contrast, we argue that curricular content is expanding steadily along with emerging scientific and technological developments. However, we realized that the time available for educating the next generation of scientists is not. We contend that a solution is required that will promote student learning at deeper levels of conceptual understanding in a shorter period of time. This paper proposes that appropriately designed digital learning objects embedded within our learning design model will allow for deeper concept learning and understanding in science education.

### *The RASE Pedagogical Model*

The RASE Learning Design model can be viewed from two perspectives: (1) instructional and (2) learning. From the instructional perspective, the model assists teachers in developing a student-centered approach as well as the integration of educational technologies. From the learning perspective, the model supports students to learn disciplinary content and develop new literacies. The model builds upon important theoretical work and concepts described below.

*Constructivist learning environment* (Jonassen, 1999). In this view, learning should be arranged around activities and occur in an environment that supports knowledge construction, as opposed to knowledge transmission. Knowledge construction is a process where students individually construct their understanding of the content of the curriculum based on exploration, social engagement, testing of understanding and consideration of multiple perspectives. Underlining constructivist learning environments is Activity Theory, initially proposed by Lev Vygotsky (1978) and his followers such as Leont'ev (1978), and articulated in a more specific framework by scholars such as Engeström (1987). Activity Theory specifies components which underline

any activity system and are important to consider in planning, managing and facilitating performance. To understand learning, it is important to understand the specifics of an activity, as well as the tools used in the process.

*Problem solving* (Jonassen, 2000). For Jonassen, learning is most effective when it occurs in the context of an activity that engages students to solve ill-structured, authentic, complex and dynamic problems. These types of problems differ significantly from logical, well-structured problems with a single solution. These types of problems include dilemmas, case studies, strategic decision-making and design, all of which require learners to engage in deep thinking, examination of multiple possibilities, deployment of multiple theoretical perspectives, uses of tools, creation of artifacts, and exploration of possible solutions. Students learn by solving complex problems rather than by absorbing ready-made rules and procedures.

*Engaged learning* (Dwyer *et al.*, 1985–1998). Dwyer, Ringstaff and Sandholtz conducted a longitudinal study to investigate the most effective adoption of Apple technology in a student-centered learning environment (i.e., the Apple Classroom of Tomorrow). These scholars argue that technology must serve as a tool for learning, which supports engagement in activities, collaboration and deep learning. Central to their work is the concept of ‘engaged learning’, which is critical in making students more active in their learning and uses of technology.

*Problem-based learning (PBL)* (Savery & Duffy, 1995). Savery and Duffy propose PBL as an optimal design model for student-centered learning. Similar to those above, PBL builds upon constructivist philosophy and contends that learning is a process of knowledge construction and social co-construction. One of the features of PBL is that students actively work on activities which are authentic to the environment in which they would be naturally used, that is, students construct knowledge in the contexts which reassemble those in which they would use that knowledge. Creativity, critical thinking, metacognition, social negotiation, and collaboration are all perceived as a critical component of a PBL process. One of the key characteristics of PBL is that teachers should not primarily be concerned with the knowledge students construct, but should focus, more attention on metacognitive processes.

*Rich environments for active learning* (Grabinger & Dunlap, 1997). Similar to Savery and Duffy, Grabinger and Dunlap propose PBL as a highly effective educational intervention. However, in their approach further attention is given to the context of the environment in which PBL occurs, considering further aspects of components and complexities that such an activity requires. In particular, emphasis is placed upon making students more responsible, willing to provide initiatives, reflective and collaborative in the context of dynamic, authentic and generative learning. This approach also emphasizes importance of the development of lifelong learning skills.

*Technology-based learning environments and conceptual change* (Vosniadou *et al.*, 1995). In this view, the central role of technology is to support

students' conceptual changes and concept learning rather than simple knowledge transfer. Students construct mental models and other internal representations via attempts to explain the external world. Students often bring prior misconceptions to learning situations. Therefore, instructions ought to be designed to correct such misconceptions. Technology will scaffold not only presentation of effective external representations of conceptual knowledge, but also externalization of internal representations so that teachers can gain insight into students' knowledge and understanding. Taking a more constructivist perspective, technology and representations will serve the role of mediators in learning activities.

*Interactive learning environments* (Harper & Hedberg, 1997; Oliver, 1999). In order to serve the complexity required for learning, Oliver proposes that a learning module must contain resources, tasks and support. For full learning to take place, a task must engage students to make purpose-specific use of resources. The teacher's role is to support learning. These integrated components will lead to interactivity essential for learning to occur. Harper and Hedberg strongly emphasize the constructivist philosophy, and argue that technology itself should provide an environment where learners can interact with tools and each other. Similar to Jonassen (2000), Hedberg supports problem-based approaches as the most effective educational intervention. Although this perspective was pioneered in the early stages of educational multimedia adoption and development of software tools, the current paradigm appears to be further advanced and provides possibilities to transfer between environments in a ubiquitous manner.

*Collaborative knowledge building* (Bereiter & Scardamalia, in press). Knowledge building is a theoretical construct developed by Bereiter and Scardamalia to provide interpretation of what is required in the context of collaborative learning activity. Personal knowledge is seen as an internal, unobservable phenomenon and the only way to support learning and understand what is taking place is to deal with the so-called public knowledge (which represents what a community of learners know). This public knowledge is available to students to work on, expand and modify through discourse, negotiation, and collective synthesis of ideas.

*Situated learning* (Brown *et al.*, 1989). Brown and colleagues build upon the Activity Theory perspective to emphasize the central role of an activity in learning. An activity is where conceptual knowledge is developed and used. It is argued that this situation produces learning and cognition. Thus, activity, tools and learning should not be considered as separate. Learning is a process of enculturation where students become familiarized with uses of cognitive tools in the context of working on an authentic activity. Both activity and how these tools are used are specific to a culture of practice. Concepts are not only situated in an activity, but are progressively developed through it, shaped by emerging meaning, culture and social engagement. In Vygotsky's terms, concepts have history, both personal and cultural. Concepts can only

be understood and learnt at a personal level through their uses within an activity. Active tool use and interaction between tools and an activity leads to increased and ever-changing understanding of both the activity and the context of tool use, and the tool itself. The tool use might differ between different communities of practice, so learning how to use a tool specific to a particular community is a process of enculturation. How a tool is used reflects how the community sees the world. Concepts also have their own history and are a product of socio-cultural developments and experience of members of a community of practice. Thus, Brown and colleagues strongly suggest that activity, concept and culture are interdependent, in that “the culture and the use of a tool determine the way practitioners see the world, and the way the world appears to them determines the culture’s understanding of the world and of the tools. To learn to use tools as practitioners use them, a student, like an apprentice, must enter that community and its culture” (pp. 33). Hence, learning is a process of enculturation, where students learn to use a domain’s conceptual tools in an authentic activity.

*Inquiry-based learning supported by technology.* Work under this general concept includes practically oriented frameworks and design guidelines for building technology-based learning modules. These include approaches such as Quest Atlantis (Barab *et al.*, 2005), Micro Lessons (Divaharan & Wong, 2003), Active Lessons (Churchill, 2006), and Web Quest (Dodge, 1995). Similar to the previously discussed theoretical work, this approach elevates the importance of learning activity as critical for an effective educational intervention. Learning begins with an inquiry or a problem (supported with a multimedia presentation) being presented to students in an interesting way. The students are then assigned to a task(s), provided with a template to assist them in the completion of the task(s), directed to Web-based and other resources to assist them and collaborative tools such as discussion platforms. Most often, students use technology-based tools in completing their tasks and are directed to submit outcomes via electronic means. As a design model, these approaches make a significant step in directing teachers to move away from the traditional, content-driven, teacher-centered use of technology.

What can be observed from these ideas is that activity and conceptual knowledge are central to learning. Based upon these theoretical and conceptual models, we developed the RASE Learning Design model as an important tool to support the activity of instructional planning.

The central idea behind RASE is that content *resources* are not sufficient for full achievement of learning outcomes. In addition to resources, teachers need to consider the following:

- Activity for students to engage in using resources and working on tasks such as experiments and problem solving leading through experience towards learning outcomes.

- Support to ensure that students are provided help, and where possible with tools to independently or in collaboration with other students, solve emerging difficulties.
- Evaluation to inform both students and teachers about progress and to serve as a tool for understanding what else needs to be done in order to ensure learning outcomes are achieved.

Figure 1 is a visual representation and summary of the RASE Learning Design model. Readers are urged to consider all of the components and think about ways how these can be integrated in a holistic learning environment in their own practice.

*Figure 1: The RASE pedagogical model*



### *Resources*

Resources include (a) content (e.g., digital media, textbooks, a lecture by a teacher), (b) material (e.g., chemicals for an experiment, paint and canvas), and (c) tools that students use when working on their activity (e.g., laboratory tools, brushes, calculators, rulers, statistical analysis software, word processing software). When integrating technology resources in teaching, it ought to be done in a way that leads students to learn with, rather than just learn from these resources. In this way, students can develop elements of their overall new literacies. There are various software tools that students can use in learning (e.g., the Mind Mapping tool such as Mind Meister, the image/video editing tool such as iMovie, professional tools such as AutoCAD and Math-

ematica, and model building and experimentation tools such as Interactive Physics and Stella).

What kind of digital content resources might be effective for science and engineering learning, in particular for science concept learning, and development of new literacies? We argue that 'Conceptual Models Learning Objects' should be given consideration by science and engineering educators. Over the last decade, we have conducted extensive research work on design and educational uses of learning objects (see Churchill, 2005, 2007, 2008, 2010, 2011a, 2011b, in press; Churchill & Hedberg, 2008; Jonassen & Churchill, 2004).

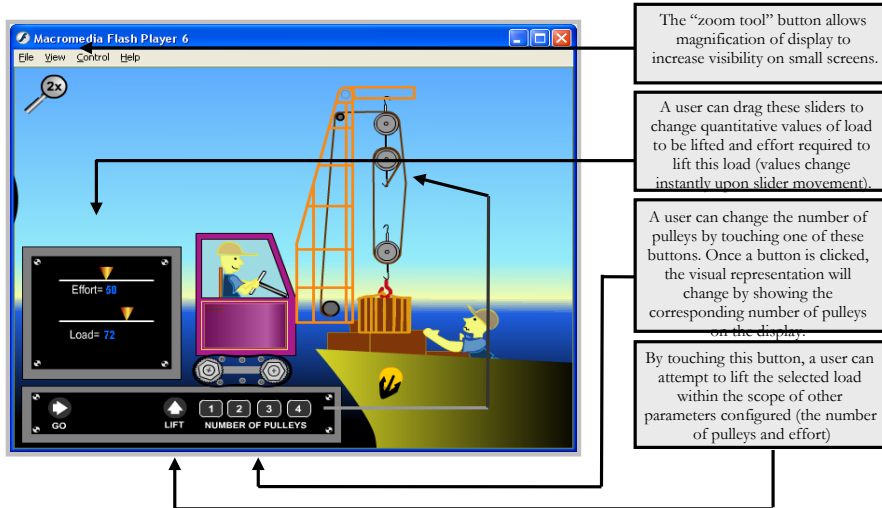
A concept is broadly understood as a specific form of cognitive structure that enables a knower to understand new information, and engage in specific disciplinary thinking, problem-solving and further learning. The literature underlines the importance of conceptual learning, and refers to evidence that incomplete conceptual knowledge and misconceptions seriously impede learning (see Mayer, 2002; Smith *et al.*, 1993; Vosniadou, 1994). Models have been described in literature as effective tools for conceptual learning. Their educational use has been in the areas of model-centered learning and instruction (e.g., Dawson, 2004; Gibbons, 2008; Johnson & Lesh, 2003; Lesh & Doerr, 2003; Mayer, 1989; Norman, 1983; Seel, 2003; van Someren *et al.*, 1998).

A conceptual model learning object is designed to represent a specific concept (or a set of related concepts) and its properties, parameters and relationships. A learner can manipulate these properties and parameters with interactive components (e.g., sliders, buttons, hotspot areas, text input boxes) and observe changes displayed in a variety of modes (e.g., numerical, textual, auditory and visual). These resources require little contact time for maximum learning and conceptual knowledge to be constructed.

Figure 2 shows an example of a conceptual model learning object. This learning object is an interactive and visual representation of a concept of mechanical transfer of power through a pulleys system. It allows students to manipulate a number of parameters and observe the impact of the configuration on the pulleys system. In order to realize the full educational potential of this learning object, a teacher needs to create a task (activity) within which students will be engaged in inquiry and exploration of underlining relationships embedded in the learning object. A student could reposition the two sliders in order to change values of the load to be lifted and the effort to be exerted to lift this load, or vice versa. Uncovering these relationships should lead to deeper understanding of the key concepts represented by the learning object. This deep understanding might, in the longer term, be supported by perceptual impressions and individuals' cognitive ability to recreate interaction in the mind through imagination.

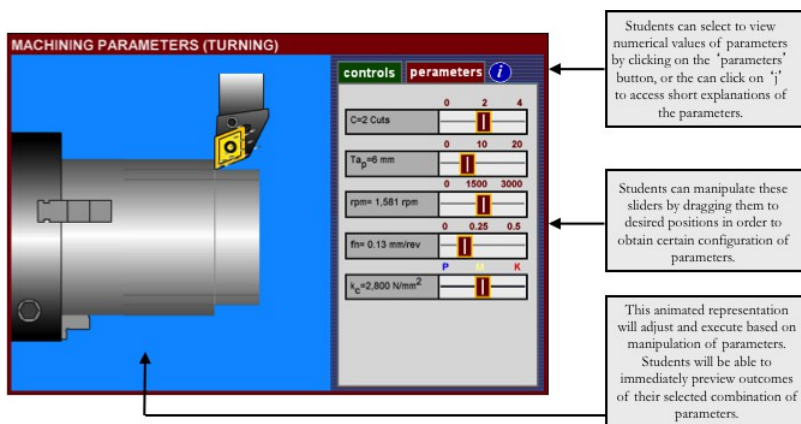


Figure 2: “Pulleys System” learning object  
(from: Churchill & Hedberg, 2008)



Another example of a learning object is presented in Figure 3. This learning object depicts the key machining parameters in machining (turning). We used engineering in order to demonstrate relevance of the idea to other domains. Learners can manipulate these parameters and explore optimal combinations required to complete a machining task.

Figure 3: “Machining Parameters” learning object



The following scenarios, explicated from previous research, describe how conceptual model learning objects might support science learning:

(1) *Observation* – A conceptual model can support students to make links between the real world and the represented properties of a concept. It can be designed so that learners can recognize properties from a real environment in the interface of a conceptual model, as well as the converse. These representations of properties are not simply copies of the real world. Rather, reality is represented through illustrations, diagrammatical representations, analogies, metaphors, signs, cues, symbols, and icons.

(2) *Analytical uses* – A conceptual model would allow students to import data from the real environment and experiments for analytical processing (e.g., a special purpose calculator). Design features (e.g., sliders, dialers, hot-spot areas and text input boxes) enable the input of parameters. Outcomes of interactions can be displayed in a variety of formats such as numbers, graphs, audio, verbal/written statements, pictorial representations, and animation.

(3) *Experimentation* – A conceptual model would enable learners to manipulate parameters and properties, and observe changes that result from such manipulations. Also, it might allow the manipulation of outcomes of analytical use to enable students to examine how these changes affect the related parameters. The changes can be highlighted to provide cues and encourage generalizing. A conceptual model's design features allow emergent generalizations to be tested.

(4) *Thinking* – A conceptual model might include features that initiate and support scientific thinking. In relation to science concepts, this can be achieved by integrating triggers (e.g., signals and cues) that capture attention and initiate curiosity. Furthermore, a conceptual model might support the cognitive activities of linking mental models of concepts (verbal and visual) developed through interaction with its content.

Conceptual models can be reused in different environments and activities. For example, reuse might include a classroom or a laboratory presentation, or use by multiple learners as they collaborate on science tasks. Lately, there has been an increase in conceptual models and other learning objects available via mobile technologies such as iPods. The author refers to these as Learning Object Apps. Mobile technologies enable these resources to be taken to authentic contexts, moved between classrooms, laboratories and real world and used by students independently outside of their schools and whenever needed. The reader is reminded that resources are only one component of a learning unit. Consideration also needs to be given to activity, support and evaluation.

### *Activity*

An activity is a critical component for full achievement of learning outcomes. An activity provides students with an experience where learning occurs in the context of emerging understanding, testing ideas, generalizing and applying knowledge. Resources, such as conceptual model learning objects, are tools that students use while completing their activity. The following are the two key characteristics of an effective activity:

- (1) An activity must be ‘Student-centered’:
  - It focuses on what students will do to learn, rather than on what students will remember,
  - Resources are tools in students’ hands,
  - Teachers are facilitators who participate in the process,
  - Student produce artifacts that demonstrate their learning progress,
  - Students learn about the process,
  - Students develop new literacies.
- (2) An activity must be ‘authentic’:
  - It contains real-life scenarios and ill-structured problems,
  - It reassembles professional practice,
  - It uses tools specific to professional practice,
  - It results in artifacts that demonstrate professional competence, not only knowledge.

The following are examples of what an activity may be:

- (1) A design project (e.g., design an experiment to test scientific hypothesis),
- (2) Case study (e.g., a case of how a scientist identified new physics regularity),
- (3) A problem solving learning task (e.g., minimizing friction in the design of skis),
- (4) Develop a documentary movie on a specific issue of interest (e.g., GM food pros and cons),
- (5) A poster to promote a controversial scientific issue (e.g., Nuclear energy),
- (6) Planning science day in your school,
- (7) Develop a software to control mechanical transfer of power,
- (8) Role-play (e.g., defending science experiment with small animals).

The outcome of an activity can be a conceptual artifact (e.g., an idea or a concept presented in a written report), a hard artifact (e.g., a model of an electric circuit), or a soft artifact (e.g., a computer-based creation). Artifacts produced by students ought to undergo peer and expert review and revision before final submission. This process may also involve student presentations and peer/expert feedback. The produced artifacts ought to be evaluated in ways that students can reflect upon feedback and take further action towards a more coherent achievement of the learning outcomes.

### *Support*

The purpose of support is to provide students with essential scaffolding while enabling the development of learning skills and independence. For teachers, one aim is to reduce redundancy and workload. Support might anticipate students' difficulty, such as understanding an activity, using tools or working in groups. In addition, teachers must track and record the ongoing difficulties and issues that need to be addressed during learning, and share these with students. Three modes of support are possible: teacher-student, student-student, and student-artifact (additional resources). Support can take place in a classroom and in online environments such as through forums, Wikis, Blogs and social networking spaces.

Support can also be seen as anticipatory of student needs. Depending on the course, proactive support structures such as FAQs can be planned and implemented in light of such needs. The objective of anticipatory support is to ensure students have access to a body of resources when they need help, rather than being dependent on asking teachers for help. Here are some specific strategies:

- (1) Build a body of resources and materials which form an FAQ Page,
- (2) Create a "How Do I?" or "Help Me" Forum,
- (3) Create a Glossary of course-related terms,
- (4) Use checklists and rubrics for activities,
- (5) Use other social networking platforms and synchronous tools such as chat and Skype.

Overall, the support should aim at leading students to become more independent learners. Teachers should give frequent, early, positive feedback that supports students' beliefs that they can do well. Furthermore, students also need rules and parameters for their work. For example, before students can ask teachers for help, they must first ask their classmates through one of the Forums and/or search the Internet for solutions to their problem(s). In this way, students are expected to take responsibility for their learning and to support other students in their cohort.

### *Evaluation*

Evaluation of student learning during the semester is an essential part of effective student-centered learning experiences. The evaluation needs to be formative in order to enable students to constantly improve their learning. An activity should require students to work on tasks, and develop and produce artifacts that evidence their learning. This evidence of student learning enables the teacher to monitor student progress and provide further formative guides to help improve students' learning achievement. Students also need to record their progress in completing the tasks set, so they too can monitor their

learning and the improvements they make. Rubrics can be provided to enable students to conduct self-evaluation as well. In addition, evaluation might be conducted by peers as well. Here are a few points why evaluation is important to student learning:

- (1) Offers feedback on work and identifies where students are in their learning,
- (2) Offers opportunities for students to improve their work,
- (3) Enables students to become more effective and motivated learners,
- (4) Helps students become more independent and self-directed learners.

### *Putting it All Together*

The following set of recommendations might be useful to teachers to develop their learning units based on the RASE Learning Design model. Before beginning to build a learning unit, teachers need to:

- (1) Ensure that specific course learning outcomes are aligned with overall programme learning outcomes,
- (2) Identify learning units required to achieve learning outcomes,
- (3) Align assessment, learning units and learning outcomes.

These should be presented in an overall Course Outline document where details of the course, including learning outcomes, schedule and topics, and information about evaluation/assignments are clearly presented and aligned. Only then is a teacher able to develop and present learning units as follows:

- (1) Describe a topic,
- (2) Present learning outcomes,
- (3) Describe what to expect and what to do if Support is required,
- (4) Explain prerequisites and how to build on previous learning,
- (5) Describe an Activity,
- (6) Explain the tasks within the activity,
- (7) Provide instructions about how to proceed initially,
- (8) Describe deliverables (artifacts to be produced), provide templates if any, provide examples of deliverables if any,
- (9) Present standard for Evaluation and provide rubrics,
- (10) Provide self-check and peer evaluation form if required,
- (11) Explain support options.

Furthermore, we need to provide Resources such as:

- (1) Notes, articles and books,
- (2) Presentations, demonstrations and recorded/real lectures,
- (3) Interactive material such as conceptual models and other forms of learning objects,
- (4) Videos,

- (5) Software tools,
- (6) Support tools.

We also need to clearly specify what is expected from evaluation and how it will be conducted, so that students have clear reference points for their work.

### Conclusion

Today, there are new challenges for science education. These include the lack of adequate focus on the development of conceptual knowledge, insufficient time to allow students to develop deep conceptual knowledge, inadequate strategies to promote the development of new literacies and emerging competencies required for today's learning, working and intellectual performance. This paper argues that teachers need a learning design model to assist their instructional planning in a way that will help them overcome such challenges. The model presented here is composed of four integral components: Resources, Activity, Support and Evaluation. Conceptual model learning objects are introduced as one effective type of digital resources for concept learning. Science education needs to remain flexible and open to technological advances. Technologies and tools, although seen to be significantly improving performance in scientific education, also scaffold a deeper understanding of scientific concepts. Technology cannot yet think for us, nor can it create innovative solutions to emerging problems. Without doubt, human intelligence is critical for this purpose. However, human intelligence, without deep conceptual knowledge and new literacies through which to productively use technology, may not take science education beyond our current horizon.

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ЈЕДАН МОДЕЛ УЧЕЊА У НАСТАВИ ПРИРОДНИХ НАУКА У 21. ВЕКУ  
*Анстракт*

Савремени токови развоја технологије и друштва захтевају темељне промене образовне праксе. Наставници и школе не представљају више пуке изворе знања који ученицима обезбеђују информације. Напротив, њихова примарна улога постаје подучавање ученика новим врстама писмености и развој компетенција за ефикасну употребу информационих технологија и задовољавајућих основа појмовног знања својственог различитим научним дисциплинама. Све ово захтева промене које подразумевају активности усмерене на ученика. У таквом контексту, наставници постају дизајнери учења, па се стога појам планирања часова замењује концептом „нацрт за учење“. У овом раду представља се модел учења у настави природних наука RASE (Resource-Activity-Support-Evaluation), који је развијен као оквир који треба да помогне наставницима у осмишљавању модула учења. Најважнија карактеристика модела RASE јесте нагласак на осмишљавању активности у којима се ученици ангажују у коришћењу ресурса и стварању артефаката који показују шта је научено. У раду се такође указује на важност „појмовних модела“ као посебне врсте образовних мултимедијалних ресурса и њихове улоге у подршци учењу и примени појмова, насупрот моделу „трансфера информација“. RASE се све више користи као ефикасан модел за процес трансформације наставника и традиционалних метода рада у савремену, релевантну праксу усмерену на ученика. Овај модел, такође, представља делотворан оквир за ефикасну употребу информационих технологија у образовању.

*Кључне речи:* модел учења, настава природних наука, учење усмерено на ученика, нацрт за учење.

Дэниэль Черчилль, Марк Кинг и Боб Фокс  
ОДНА МОДЕЛЬ ОБУЧЕНИЯ В ПРЕПОДАВАНИИ  
ЕСТЕСТВЕННЫХ НАУК В 21 ВЕКЕ

*Резюме*

Современные направления развития технологии и общества требуют основательных перемен в образовательной практике. Учителя и школы не являются теперь только источниками знаний, которые обеспечивают учеников информацией. Наоборот, их первичной ролью становится обучение учеников новым видам грамотности и развитию компетенций для эффективного использования информационных технологий и удовлетворительных основ понятийного аппарата, характерного для различных научных дисциплин. Все это требует изменений, которые предполагают деятельность, направленную на учеников. В таких обстоятельствах учителя становятся дизайнерами обучения, поэтому понятие „планирование уроков“ заменяется концептом „эскиз обучения“. В этой работе представлена модель обучения в преподавании естественных наук RASE (Resource-Activity-Support-Evaluation), который был разработан как основа, помогающая учителям в осмыслении модуля обучения. Самой важной характеристикой модели RASE является упор на осмысление деятельности, при которой ученики участвуют в использовании ресурсов и создании объектов, демонстрирующих то, что было усвоено. В работе также подчеркивается важность „понятийных моделей“ как отдельного вида образовательных мультимедийных ресурсов и их роли в поддержке обучения и применении понятий, в противовес модели „трансфера информации“. RASE все больше используется в качестве эффективной модели процесса трансформации учителей и традиционных методов работы в современную, релевантную практику, направленную на ученика. Эта модель также представляет плодотворную основу для эффективного употребления информационных технологий в образовании.

*Ключевые слова:* модель обучения, преподавание естественных наук, обучение, направленное на ученика, эскиз обучения.