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Research Artikel

DESIGNING AND DEVELOPING TEACHING MATERIAL OF HUMAN ANATOMY WITH THINKING MAP: WHAT IS INTERNAL RELEVANCE AND CONSISTENCY?

PERANCANGAN DAN PENGEMBANGAN MATERI AJAR ANATOMI TUBUH DENGAN PETA BERPIKIR : APA ITU RELEVANSI DAN KONSISTENSI INTERNAL?

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Abstract

The purpose of this study was to investigate the relevance and internal consistency in the design and develop of human anatomy teaching materials using the thinking map. This research is an educational design research consisting of preliminary, prototyping and assessment. At preliminary stage, researcher doing activity of instructional analysis of human anatomy material. At the prototyping stage, researchers designed the prototype of anatomical material using thinking map. Then the prototype is judged by the expert. Revisions are made on the basis of the expert's assessment. Human anatomical material on the topics: human cells, basic tissues, integument systems, skeletal systems, muscular systems, digestive systems, respiratory systems and reproductive systems used as a content thinking map. Product quality is determined from internal relevance and consistency. The aspect of relevance and internal consistency is determined by the validity the content and construct validity. Indicators contained in the content validity instrument are language, image, subject, curriculum, purpose, concept, constructivism. The construct validity indicators are: consistent, flexible, growing, integrative and reflective. The results showed that the validator assessed 55 thinking maps of human anatomical material that had been designed with a valid mean score. Revisions have been made to improve product consistency. Product thinking map is also done through a good development process. Based on the results and discussion of the research it can be concluded that the human anatomy teaching material has been obtained using a map of thought with good internal relevance and consistency. Broader test or large group test is required to improve product resistance to revisions.

Keywords:relevance; internal consistency; human anatomy; thinking map

Abstrak

Tujuan dari penelitian ini adalah untuk mengetahui relevansi dan konsistensi internal dalam perancangan dan pengembangan bahan ajar anatomi manusia dengan menggunakan peta pemikiran. Penelitian ini merupakan penelitian desain pendidikan yang terdiri dari pendahuluan, prototyping dan penilaian. Prosedur penelitian pada tahap awal, peneliti melakukan aktivitas analisis instruksional bahan anatomi manusia. Pada tahap prototyping, peneliti merancang prototipe bahan anatomis dengan menggunakan peta pemikiran. Kemudian prototipe dinilai oleh ahli. Revisi dibuat atas dasar penilaian ahli. Materi anatomi manusia pada topik: sel manusia, jaringan dasar, sistem integumen, sistem rangka, sistem otot, sistem pencernaan, sistem pernapasan dan sistem reproduksidigunakan sebagai konten peta pemetaan. Kualitas produk ditentukan dari relevansi dan konsistensi internal. Aspek relevansi dan konsistensi internal ditentukan dengan teknik validitas isi dan validitas konstruk. Indikator yang terdapat dalam instrumen validitas konten adalah bahasa, gambar, subjek, kurikulum, tujuan, konsep, konstruktivisme. Indikator validitas konstruk adalah: konsisten, fleksibel, berkembang, integratif dan reflektif. Hasil penelitian menunjukkan bahwa validator menilai 55 peta pemikiran bahan anatomi manusia yang telah dirancang dengan skor rata-rata yang valid. Revisi telah dilakukan untuk meningkatkan konsistensi produk. Pemetaan pemikiran produk juga dilakukan melalui proses pengembangan yang baik. Berdasarkan hasil dan pembahasan penelitian dapat disimpulkan bahwa bahan ajar anatomi manusia telah diperoleh dengan menggunakan peta pemikiran dengan relevansi internal yang baik dan konsistensi. Tes yang lebih luas atau tes kelompok besar diperlukan untuk memperbaiki ketahanan produk terhadap revisi.

Kata Kunci*:relevansi; konsistensi internal; anatomi; peta pemikiran*

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PENDAHULUAN

Anatomy is the study of structure and relationship between body parts (Pack, 2007). Many ways can be done to study anatomy material. Patrick & Tunnicliffe (2010) has reported about that the teachers were given a blank piece of standard paper and were asked to write subjects taught and subject most often taught. The teachers were able to draw individual organs, but they were not able to draw the organs in relation to the organ systems. Šorgo (2010) tried to enrich teaching human anatomy in high school biology lessons. The result study shown that students construct dichotomous identification keys to the cells, tissues, organs, or body parts. By doing this, students have achieved higher-order cognitive levels of knowledge because construction of such keys is based on analysis, synthesis, and evaluation. Students found the method useful but not easy to perform. Reiss & Tunnicliffe (2001) given a blank piece of A4-sized paper and asked to draw what they thought was inside themselves. The resultant drawings were analyzed using a seven-point scale where the criterion was anatomical accuracy. Drawing on approaches used in the disciplines of visual design and visualculture. The findings research by Tunnicliffe & Reiss (1999) are interpreted with reference to current trends in English science curricula and pedagogy, in particular on the current inability of most students to see the skeleton as a functional, integrated whole. Tunnicliffe & Ueckert (2007) was explained that teaching biology is the great dilemma because teaching biology is exciting, a popular strategy used by high school biology teachers is hand-on experience, which provides students with the opportunity to manipulate materials and perform investigation. The explanations show that the use of images, integration curriculum, and identification keys to study anatomy still lacks, so another way is needed to study and teach anatomical material.

As the language of the cognitive process pattern, eight types of thinking maps (Hyerle, 2012; Thinking Maps, 2007)is an effective strategy to improve student learning outcomes in science learning (Salah & Abu-Owda, 2014). Thinking maps can also be used by students to expand their critical thinking skills and improve understanding and mastery of learning materials (Long & Carlson, 2011)such as brain-based learning and multiple intelligences (McDonnell & Zeni, 2003). There are eight types of thought maps, namely circle maps-help define a word or thing in context and present what is seen; bubble map-describes emotional, sensory, and logical qualities; double bubble map-compare quality; a tree map-shows the relationship between the main idea and the supporting details; binder map-shows events as sequences; flow maps-show cause and effect and help predict outcomes; plural flow maps-shows the physical structure and the overall relationship and bridge map-helps transfer or form analogies and metaphors (Hyerle, 1995; Conroy & Hyerle, 2012).

Before thinking map was introduced and used in learning (Thinking Maps, 2007),concept map is a medium that is widely used in learning. Because concept maps are learning tools to help students acquire problem-solving skills (Tsai & Huang, 2002). The use of concept maps also increases student interest and achievement (Chiou, 2008). The use of other concept maps in biology learning has also been reported from several other studies. For example the use of concept maps to map the skeletal system (Marée, Bruggen, & Joche, 2013), use and application validation of concept map programs (Steiner, Albert, & Wan, 2017) and the use of concept maps to construct power point presentations (Kinchin, 2006).

Concept maps are also used by teachers and students in the learning process because concept maps are considered as an effective way of dialogue between teachers and students (Kinchin, 2010). The use of concept maps by teachers is considered as an alternative assessment strategy in the biology class (Kinchin, 2000), and its use affects students' cognitive skills in selected biological concepts (Lalor & Rainford, 2014). Concept maps are instructional strategies that are widely used by students to study biology in high school (Schmid & Telaro, 1990)to visualize the structure of knowledge (Kinchin, 2011).

But now, the use of thinking map is considered more able to help students to see, change, imagine and improve students' thinking ability (Conroy & Hyerle, 2012). Because thinking in the world of education should be integrated in the learning process (Haviz, 2009). The use of thinking map is also able to improve students' science process skill. Because the thinking map provides an opportunity for students to understand the content of the lesson carefully, connecting and visualizing the concept of the lesson, enhancing student co-operation, motivating the students and enabling students to experiment in the process of science (Salah & Abu-Owda, 2014). In another study, the use of thinking maps can be used with cooperative learning models (Haviz, 2015), and integrative learning models (Haviz, 2013; Haviz, Lufri, Fauzan, & Efendi, 2012). Because both are ways of learning and teaching that apply the principles of modern instruction (Haviz, 2015). The results of this study show that student learning outcomes are improved and good by using a thinking map. So, the use of thinking map in other biology learning materials, such as human anatomy can also be visualized by thinking map.

To visualize human anatomy material into thinking map it is necessary to do educational design research. Because educational design research is a systematic study of the process of designing, developing and evaluating models, programs, teaching-learning strategies and tools, products, and systems as a solution to complex problems in practical education, and also aims to increase knowledge about the characteristics of models, programs, teaching strategies and their devices, products, and systems. Second, the general stages of development research consist of the process of design, development, evaluation and implementation. Third, the determination of focus, process, conclusions and research results will determine the type and form of research development that will be conducted by researchers who want to do research development in the field of learning. Fourth, the use and selection of evaluation techniques largely determines the quality of models, programs, teaching strategies and their tools, products, and systems (Haviz, 2013; Plomp, 2010).

The research question is how is the internal relevance and consistency in the design and development of human anatomy teaching materials using thinking map? The purpose of this study is to investigate the relevance and internal consistency in the design and develop of human anatomy teaching materials using the thinking map.

METHOD

This research is an educational design research consisting of preliminary, prototyping and assessment (Plomp, 2010). Procedure of research at preliminary stage, researcher doing activity of instructional analysis of human anatomy material. At the prototyping stage, researchers designed the prototype of anatomical material using thinking map. Then the prototype is judged by the expert (Tessmer, 1993). Revisions are made on the basis of the expert's assessment.

Human anatomical material on the topics: human cells, basic tissues, integument systems, skeletal systems, muscular systems, digestive systems, respiratory systems and reproductive systems (Pack, 2007) used as a content thinking map. Product quality is determined from internal relevance and consistency (Nieveen, 2010). The aspect of relevance and internal consistency is determined by the validity technique used. The validity chosen is the content and construct validity. Indicators contained in the content validity instrument are language, image, subject, curriculum, purpose, concept, constructivism. The construct validity indicators are: consistent, flexible, growing, integrative and reflective. Prior to use, this instrument has been assessed by an expert. Expert judgment results show that the instrument scores an average of 3.25 on a valid category. So concluded this instrument can be used for the next stage of research.

To collect data, 3 validators perform a prototype assessment. Validators are selected based on criteria: experts and practitioners in the field of anatomy and biology learning. The validator fills in the scoring instrument sheets that have been developed. The average scoring scores of the validators were analyzed by descriptive statistics. The average score is converted to the following criteria, if mean score (M) > 3.20 is highly valid; $2.40 <$ mean score (M) ≤ 3.20 is valid; $1.60 <$ mean score (M) ≤ 2.40 is less valid; $0.80 <$ mean score (M) ≤ 1.60 is valid; mean score (M) ≤ 0.80 is invalid.

RESULT AND DISCUSSION

Preliminary Stage

The preliminary stage results show that the basic competence of this human anatomy learning material is that students are able to understand the structure and development of the human body from the cell to adulthood, to understand the various tissues that build the human body, to understand the human integument system, to understand the human skeletal system, to understand the muscular system in humans, understand the digestive system in humans, understand the respiratory system in humans, and understand the reproductive system in humans.

Prototyping Stage

Prior to the design of prototypes, researchers designed the matrix of anatomy materials using thinking map. The matrix is listed in Table 1.

Table 1. The prototype matrix of developing human anatomy materials using thinking map

Educational Design Research(Plomp, 2010)		*Characteristic*(Conroy & Hyerle, 2012)				
		C	F	G	I	R
Preliminary stage	Instructional analysis	●	●	●	●	●
Prototype stage	Design prototype	●	●	●	●	●
	Expert review	●	●	●	●	●
	Revision	●	●	●	●	●
Assessment stage	Summative evaluation	●	●	●	●	●

(●) shows the components present in the matrix.

Information:
- C = Consistent
- F = Flexible
- G = Growing
- I = Integratif
- R = Reflective

Table 2. Summary of human anatomy material using thinking map

Thinking Map	human anatomy material using thinking map							
	human cells	basic tissues	integument systems	skeletal systems	muscular systems	digestive systems	respiratory systems	reproductive systems
circle map	-	-	-	-	-	-	-	-
bubble map	human cell function, ribosome properties, mitochondrial character, cytoskeletal classification, nuclear component, cell composition	classification of basic tissue, epithelial classification, epithelial characteristics, glandular epithelial classification, connective tissue constituent components, classification of connective tissue, muscle constituents of the human body, neurons	function of the skin, layers of skin, organs of skin,	skeletal bones, skeletons of human skulls (cranium), vertebral bone columns, bones of pectoral bracelets and front members, pelvic bracelet bones and rear members	muscle builders, muscle function, muscle cells, muscle builders of the human body, classification of human muscles	functions of the digestive system, channels and gastrointestinal tract, oral cavity and parts thereof, function of the tongue, dental part, human salivary gland, pharyngeal structure, esophageal structure, ventricular structure, gut structure	respiratory organs, nasal structures, pharyngeal divisions, laryngeal cartilage, tracheal wall lining, primary bronchial wall lining, secondary bronchial wall lining, alveolar membrane lining,	male reproduction system composer, testes structure, secondary reproductive organs, female reproduction system, female reproductive tract, uterine lining, female external reproductive organs
double bubble map	differences in animal cells with plant cells, differences in smooth endoplasmic reticulum with rough endoplasmic reticulum	-	-	-	-	-	-	-
tree map	-	-	-	-	-	-	-	-
binder map	-	-	-	-	-	-	-	-
flow map	-	-	-	-	-	-	-	-
plural flow map	-	-	-	-	-	-	-	-
bridge map	-	-	-	-	-			
Total	8	8	3	5	5	11	8	7

The prototype design is based on the prototype matrix of developing human anatomy teaching materials using thinking map. The summary of the design results is given in Table 2. In Table 2 it is seen that there are 55 pieces of anatomical material visualized to the thinking map (Hyerle, 2012; Hyerle, 1995). Furthermore, this prototype is done by expert assessment. The validity test results are given in Table 3. The results of the validity test show that the prototype scores with a valid mean score. The validator team provides suggestions for revisions to the consistency aspects of the use of the term in the mind map and the use of images in the product book.

The result of research shows that the relevance and internal consistency of educational design research has been fulfilled. In this study we have tested the content and construct validity. In development research, validity test is one of the research steps to determine the relevance and internal consistency of product that has been designed (Nieveen, 2010). The process of developing anatomy teaching materials using the thinking map shows a test to determine the resistance of the product, i.e. expert review test (Tessmer, 1993). Based on Tesmer evaluationtechniques, expert review is a second level product test technique. Products tested by expert review techniques tend to be less resistant to revisions. These explanations show the process of research in educational development. This explanation also shows that in this study has fulfilled the internal relevance and consistency aspects of educational design research.

Table 3. Validity test resultshuman anatomy materials using thinking map

Aspect	Result of Validity (n expert = 3)		
	M	STDEV	Category
Consistent	3.02	0.71	valid
Flexible	3.30	0.71	highly valid
Growing	3.22	1.41	highly valid
Integratif	3.00	0.71	valid
Reflective	2.82	0.71	valid
Mean	3.26	0.85	valid

Note: M= mean score STDEV= Standard Deviation. (M) >3.20 is highly valid; $2.40 <$ mean score (M) ≤ 3.20 is valid; $1.60 <$ mean score (M) ≤ 2.40 is less valid; $0.80 <$ mean score (M) ≤ 1.60 is valid; mean score (M) ≤ 0.80 is invalid

In this study, the development of human anatomy teaching materials using thinking map is seen from research findings on aspects of product development characteristics. The prototype characteristics of teaching materials using thinking maps are consistent, flexible, growing, integrative and reflective (Hyerle, 2012). These five characteristics are tailored to the educational design research process. This result also shows that the developed teaching material can be visualized into the thinking map. The results show that anatomical material can be visualized and support the role of lecturer in discovering and describing linear and non-linear knowledge structures (Conroy & Hyerle, 2012). In this study, the research findings also show that bubble maps are the most widely used type of mind map to visualize anatomical material. These findings show that the characteristics of anatomical materials are much characterized by concepts. The bubble map is designed for the process of portraying characters and the map is used to recognize innate traits (the art of language), cultural features (social sciences), possession (science), or elements (mathematics) (Conroy & Hyerle, 2012).This explanation also shows that in this study has fulfilled the internal relevance and consistency aspects of educational design research.

The findings of this study show that the fulfillment of important aspects in the process of educational design research. Internal relevance and consistency is determined by the initial identification process (Richey, Klein, & Nelson, 2002) of the designed product, and pass through the design, assessment and revision process. Formative evaluation is carried out on the prototype to reflect the level of product resistance to the revision (Tessmer, 1993) and documenting the products that have been designed (Plomp, 2010). These results also show that there is an internal relevance and consistency in the development of anatomy teaching materials using the thinking map. The results of this study show that the educational design research is also determined from how much expectation with reality (Nieveen, 2010). The expectation of the research results with reality is evidenced after the product is done expert assessment.

CONCLUSION

Based on the results and discussion of the research it can be concluded that the human anatomy teaching material has been obtained using a map of thought with good internal relevance and consistency.The aspect of relevance and internal consistency is determined by the validity technique used. The validity chosen is the content and construct validity.

Broader test or large group test is required to improve product resistance to revisions. The use of thought maps on content with the characteristics of theory, concepts, facts and processes should be more widely used for other materials in biology learning, especially materials with similar characteristics. The use of thought maps should also involve students in the design process. So the process of mapping and transforming information to form knowledge (meta-cognitive) is more useful for students.

Based on the results and discussion of the research it can be concluded that the human anatomy teaching material has been obtained using a map of thought with good internal relevance and consistency. Broader test or large group test is required to improve product resistance to revisions.

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